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RAILWAY TESTS AT ST. LOUIS.

The plans laid out by the commission which has been appointed to conduct tests on railway motors at St. Louis indicate that this work will be carried out in a very thorough manner. Not only is it purposed to test the motors completely on the cars, in order to determine the actual performance and the heating under service conditions, but tests of acceleration and braking tests are also included in the programme. An important part of the work, which will follow the motor tests, will be the determination of track resistance and air resistance, for which purpose an excellent strip of track eight miles in length has been offered the commission. These tests should add very considerably to our information on railway work, and it will be interesting to note, in this connection, how closely the actual results compare with those given by the methods proposed for predetermining motor performances.

FUEL ECONOMY.

Economy in fuel consumption is of the first importance to us, as affecting the cost of central station operation, since at this time we are rather indifferent to the enormous drains being made upon our coal resources. In England the latter reason is beginning to have much weight, and the time has come when it is being considered there whether the exportation of this resource should not be prohibited. It is therefore somewhat startling to find an English authority charging the coal consumers of his country with wasting one-fifth of the fuel which tney burn. At a meeting of the Liverpool Engineering Society, Mr. John B. C. Kershaw read a paper entitled "Fuel Economy from the Chemical Point of View," in which the author's opinions are supported by figures, and in which he points out a method for reducing this loss. An abstract of his instructive paper is given on another page of this issue.

Solving a Chemical Problem Mechanically.

The mechanical engineer has attacked the problem in a mechanical way. He has improved the reciprocating steam engine until the limit seems to have been reached, and he is now developing the steam turbine, in expectancy of effecting still further economy in steam consumption. Passing back from the steam engine to the boiler, he has exercised much ingenuity and skill in producing a machine mechanically nearly perfect, and he has fitted this with appliances which reduce the attendance required to a minimum. This work, upon which so much time and money and skill have been expended, has been carried out by the mechanical engineer. Mr. Kershaw holds that the problem of burning fuel is a chemical one, and, for its proper solution, the knowledge of the chemist is needed. When fuel is burned on a grate, the end sought is to transfer to the water in the boiler the greatest possible number of heat units set free in the furnace. This requires that the combustion be complete, and also that the least amount of air above that necessary for combustion be admitted. Under these conditions, not only is the total available heat of the fuel set free, but a hotter fire is secured, and, under a properly arranged boiler, it becomes possible to transfer to the water the greatest amount of heat. The only way to tell when this problem has been solved is by frequent chemical analysis of the fuel and of the gases in the chimney.

Indifference to Quality of Fuel.

Another point made by Mr. Kershaw is the indifference paid by coal consumers to the quality of the fuel which is sup-

plied to them. If the amount of coal required is large, an analysis may be made before placing the order; but, this having been done, comparatively seldom is the delivery watched in order that any change in the quality may be detected and allowance made therefor. Although the coal user buys coal, what he wants are heat units. The price he pays for his fuel should be regulated by its thermal value. The importance of this is well recognized to-day by central station engineers, but in far the greater number of cases, little attention is paid to the quality of the fuel. Perhaps if the engineers of these stations realized how important it is to watch their coal and to inspect it properly —just as they do all other supplies—they would give the matter more thought. The only true inspection is a thermal or chemical one.

Consult a Chemist on Chemical Problems.

It would be well if mechanical, and electrical engineers as well, appreciated more fully the assistance which frequently could be given them by a chemist. As a rule, the training of the engineer includes but little chemistry, but this should be enough to teach him to go to a chemist when he wants chemical information. The chemist can not only save his fee many times over in a year in watching the coal supply, but he can assist in many other ways. We recall one company which not only buys its coal on specifications, but which contracts for practically all of its material in the same way. It dictates the composition of its anti-friction metals. When it buys oil, it is paying for lubricating material, and not for a name. All its paints are made up under the supervision of its consulting chemist. There are, doubtless, many other large companies which do practically the same thing, and it would pay almost every central station engineer to get the advice of a chemist on matters appertaining to chemistry. The more an art advances, the more need is there of specialists to carry it still further; but, at the same time, more opportunities occur for improvement along lines with which these specialists are unfamiliar. Mechanical and electrical engineers appreciate how necessary it is for them to work in harmony; but, unfortunately, they do not seek the aid of the chemist as freely as could be desired.

THE HIDDEN CORRESPONDENT.

An interesting phase of the excellent service rendered by wireless telegraphy in reporting the military and naval operations of the war in the far east is indicated in the report published in the *New York Times* on the morning of May 16. It will be remembered that the London *Times* has equipped a land station and a vessel with the De Forest system. The report to which we refer, after explaining why the service had been interrupted, to some extent, for several days, due to the wishes of the Japanese commanders and to a storm, goes on to say: "at present, however, it is inadvisable to disclose our position." The reason for this secrecy is not given, but this does not detract from the interest with which we may read the despatches, knowing that they come from a reliable source, giving as accurately as possible the latest news, although we can only speculate regarding the location of the correspondent. It is not even necessary for those who receive his messages to know where he is. He merely throws his report upon the air, as it were, knowing that the receiving station will catch it.

A BREAKDOWN TEST OF THE NERNST LAMP.

An interesting test of the Nernst lamp was made recently by the Philadelphia Electric Company, the object being to determine how satisfactory this lamp would be on circuits, the voltage of which is subject to considerable variation. A fuller account of this test will be found on another page of this issue. It shows that the lamp did not break down until the voltage was increased twenty-five per cent above normal. With voltages above this, the ballast broke, due to its high temperature. A comparison of the luminosities of the Nernst lamp and the incandescent lamp, under these conditions, is favorable to the former. It is much more constant as it has a voltage candle-power characteristic which bends very rapidly after passing through the normal voltage. The voltage efficiency characteristic is even more remarkable, this being, for all practical purposes, a horizontal line from normal voltage to fifteen per cent above normal. It is interesting to note also that, at a voltage below the normal, the Nernst lamp still has the advantage of the incandescent lamp so far as variations in candle-power and efficiency are concerned. This excellent regulation of the Nernst lamp is due to the iron wire ballast invented by Mr. Henry Noel Potter, the variations in the voltage being taken up principally in this device.

LAMP RENEWALS.

Our esteemed contemporary, the New York *Evening Post*, has discovered a reason which, it believes, explains why electric lighting companies are sometimes so exceedingly kind to their customers as to give them new incandescent lamps, without charge, in exchange for those burned out. The following is its explanation: "the lamps supplied by the companies are invariably 'renewed' lamps—that is to say, old lamps made new by a delicate but not expensive process; and 'renewed' lamps burn more current—much more." The result, of course, is, according to this explanation, that the consumer's bill is larger when he secures his lamps from the lighting company.

The opinion which we have held for some time, and which heretofore we have never doubted, is that the electric lighting companies are in a competing business, and it is to their interest to furnish the best light possible. An incandescent lamp has a useful life of five or six hundred hours. It will generally burn much longer than this, but the light which it gives is less than that of a new lamp, and the energy consumed is relatively more as compared with the decreased amount of light. It would, therefore, seem to be to the interest of the lighting companies to have such lamps thrown away and replaced with new; and as an incandescent lamp is an inexpensive affair—costing about fifteen cents—companies often feel that they can well afford this expense, since this helps to maintain a good service.

THE PROBLEMS OF IMPROVING ELECTRIC LAMPS.

BY HENRY NOEL POTTER.

There are six prominent systems of electric lighting, each of which can be further improved if certain problems can be solved. These systems are:

The carbon arc.

The carbon incandescent.

The flame arc (Bremer).

The enclosed vapor lamp with continuous ionization (Cooper Hewitt).

The vacuum tube lamp with intermittent ionization (McFarland Moore).

The electrolytic lamp (Nernst).

Each one of these systems has its striking advantages and any material improvement in any one, particularly of the last four named systems, which may be termed the radical element, would certainly shift the balance of trade and affect all the others, including the conservative forces comprising the first two systems.

It is thus of interest to review these systems and study their problems with an eye to the probability of immediate progress.

Let us take up the radical systems first, and begin with the flame arc. This system proposes to substitute for the relatively weak luminosity of carbon vapor the relatively stronger ones of certain metallic salts, particularly those of calcium. This is accomplished by impregnating the carbon electrodes with calcium salts and such fluxes as are necessary to produce calcium compounds of low enough melting point to drip off the carbons and thus prevent gradual incrustation by slag. The presence of such metallic vapors in the arc lowers its resistance so that a much longer arc can be maintained. This long arc is tenacious, so to speak, and can be blown out into a fan by a transverse magnetic field. This is an advantage for several reasons, as it brings the arc out from between the electrodes and makes it more effective optically and it blows the arc down while the heat carries the opaque vapors upward and away from the path of the effective light rays.

The problems are to secure a longer life and steadier burning of the carbon, together with a more certain carbon feed, without danger of extinguishing the lamp, and without "pumping" and noise.

It is also a problem to secure a whiter light by use of mixtures of salts of several metals, and also to so choose the impregnation salts as to substitute sublimation for the more usual melting and boiling of the vapor-producing ingredients. This latter is most important, as the boiling of a liquid can hardly be expected to proceed with perfect evenness, especially if it is simultaneously the cathode of a vapor conductor carrying a high-current density.

These problems have been attacked more actively in Germany than in America, perhaps owing to differences in the patent systems of the two countries.

The difficulties with the flame arc serve to emphasize the remarkable qualifications of carbon as an electrode material, in that it is not only extremely refractory but that it does not melt, but enters the gaseous phase directly from the solid phase; its oxides are gases at ordinary temperatures and are both transparent and colorless.

The nearest chemical analogon of carbon is silicon. Let us see how this compares. It is not very refractory, melts at about fourteen hundred degrees centigrade, its oxide is more refractory than silicon itself, and its specific resistance is many times that of carbon.

Many other elements might be passed in review, and the final judgment be that to surpass carbon in any useful quality is to sacrifice all its other good qualities and break with all the fundamentals of arc lamp design.

As a rule when an effect results largely from the presence of one unique factor or quality, it will be found impossible to realize in practice the full force of this factor, and every compromise made to exigencies of practice will be at the expense of this quality.

In the flame arc this quality is the great luminous efficiency of certain incandescent vapors. This is the factor which can stand the greatest reduction without sacrificing the system.

I look therefore for a flame arc construction, involving features which would be useless or fatal to the carbon arc, but which will give to the flame arc a reasonable life, with certainty of operation at a reduced efficiency, but still great enough to exceed the carbon arc in candles per watt.

The next type to consider is the enclosed vapor lamp in which the vapor is ionized to start the flow of current, which then continues to flow and maintains the vapor conductivity. The representative of this system is the Cooper Hewitt lamp, in which the peculiarities of vapor conductivity are taken advantage of in the lamp design to secure an inherent regulation when operated under commercial conditions.

This system is without doubt, in theory, the most perfect solution of the problem of transformation of electrical into light energy yet proposed. It embodies most promise for the future, but like many other things it is fettered with practical restrictions in the present. This is at least fortunate for several of the other systems.

The only transparent materials which can be worked into containing-vessels are the various glasses, and these are none of them very refractory and all more or less attacked by many of the vapors which would seem otherwise promising as luminous conductors. The exception is mercury vapor, and therefore we must put up with its spectrum, which is fortunately much better than that of many other metals, and is admirably adapted to photographic uses, and is not pathologically irritating to the eyes, nor particularly disagreeable to the masculine world.

Accepting the color as probably unchangeable for the immediate future, there are a large number of subordinate problems regarding the best sort of glass, the best material of which to make electrodes and the many problems of dimensions and arrangement of parts.

It is interesting to note that one Cooper Hewitt type is locally started by tipping the lamp, instead of merely turning the inevitable switch. The switch has become a fetish alone to be conjured when electrical effects are desired, and I welcome this reformation from the idolatry of "push the button," and recommend it to the serious attention of the wizards of the Nernst lamp, to which we shall presently devote our attention.

The next type is that in which a permanent gas under reduced pressure is transiently ionized by a high-potential stress, thereby becoming a luminous conductor, and allowing a discharge which relieves the stress, whereupon the ionization ceases and must be reestablished with such rapidity that the eye does not observe the interval. The first lamps of this type were Geissler tubes and the technical development within the tube, so to speak, seems to be to-day about where Geissler left it. The modern representative of this type is the Moore lamp, the inventor of which deserves great credit for his patience and for the progress he has made in developing apparatus by which such a rapid and even succession of flashes is produced as to simulate continuity. This light is characterized by extreme softness, good color and the possibility of practically ideal distribution. Owing to the very small amount of light given per square inch, a very long and correspondingly expensive glass structure

is required. This, however, may be made very impressive and decorative. For sign work it is entirely unique and in this field it should score a pronounced success. For signs all colors are available, and as each gas has a characteristic spectrum, some of which are much more luminous than those of oxygen and nitrogen, beautiful and striking effects may soon be looked for. Near the electrodes there is a brown deposit on the inside of the glass tube which leads one to suspect that there may be an exfoliation of the electrode material. This the writer does not believe to be necessary as there are materials which do not seem to exfoliate under conditions closely analogous to those in the Moore tube.

A cheap, practical and safe source of direct current of a voltage as high as the momentary potentials now induced would set up a truly continuous discharge through rarefied gases, which would be much brighter than the discontinuous light now secured, and if a suitable cathode could be found would result in an almost ideal system; but with these changes it would become a continuous ionization lamp of the Cooper Hewitt type, devoid of those particular features on which the identity of the Moore system rests.

The realization of this dream, however, does not seem imminent enough to cause any uneasiness in the minds of those interested in present systems.

Next to be considered is the Nernst type, which produces light by the incandesence of rare earths, some of which alone, and to an increased degree in combination with one another, may be maintained at a high incandescence, without "leaking" such a large amount of invisible energy as carbon does. The energy for which the light user must pay is the sum of that wasted in invisible radiation, plus that wasted in heating the air, plus the useful visible radition. The Nernst lamp is wasteful because its glower is in contact with air which convects heat away, but it is economical because it runs at a higher temperature than the carbon filament of an incandescent lamp of equal life and, second, because it does not fritter away so much energy in invisible radiation. It is along this latter line that probably further advance can be made by making the glower of such earths as shall be the most efficient in the visible region.

The life of the glower is favorably influenced by an increase of the alternating frequency on which it is operated. The size and cost of alternating-current transformers are reduced as the frequency is increased, so that where an installation is to be solely for lighting, the use of sixteen thousand alternations or higher will give improved Nernst lamp service.

The glower is by nature a constant current, not a constant potential device, as its resistance decreases rapidly with increase of current and, in addition to this, glowers unless most carefully made of materials prepared in the most uniform manner tend to change their resistance gradually by crystallization or because of the gradual elimination of impurities whose presence influences the initial resistance. Lamps designed to operate on a constant potential system, for instance for suburban street lighting, would require no ballasts and the gradual aging of glowers would be of small effect on the service. The greatest difficulty with the Nernst system, however, is the fact that the glowers have to be heated to make them sufficiently conducting to "start" and that perverseness of the spoiled public, who, although they are perfectly willing to light the gas, must accomplish everything electrical by turning a switch. The electrical engineer who expects any help except from the current will soon find the current his only friend, and the "ingenious automatic device" a necessary peace offering.

A small Nernst lamp without any heater or cutout was sold in Germany for a time, but was retired because lighting with a match blackened the lamp and because so many glowers were broken by hitting them with the match. Nevertheless, the price at which such a lamp could be offered should make it attractive for that class of service where a number of lamps are lighted at about the same time, and where an alcohol torch could take the place of the gas-lighter now in use with Welsbachs. Taking the lamp as it is, an improvement to be expected is the use of larger glowers, and the production of a large candle-power with fewer parts.

The argument in favor of the multiple glower lamp is that it gives warning by one or two glowers giving out before it breaks down entirely. This from another viewpoint is a serious defect, as it results practically in a lamp having often one or more broken or old glowers, so that it is not "up to candle-power" and makes a bad impression.

Let a lamp be right or dead, but no complaining invalids to be apologized for and explained to sceptics and enemies. This is in the nature of an aim not a criticism, as the making of a large current glower is a difficult problem, as yet not completely mastered, whereas small glowers may be more nearly predetermined than incandescent lamp filaments.

The heater of the Nernst lamp may be greatly improved if platinum can be eliminated, particularly if a material can be found which will durably withstand in air a higher temperature than platinum. Even at a red heat in the presence of oxygen, platinum "weathers," so to speak, and a deposit of platinum-black is formed on neighboring cool surfaces, while the wire gradually breaks down.

Certain mixtures of rare earths which would otherwise make good glowers start at too high a temperature to be practical with platinum heaters, so this constitutes a limit to development in one direction, which may some day be removed. Let no one lightly imagine that an improved heater is easy, and that he has solved the problem with a material which conducts cold and is still a solid at, say, one thousand degrees centigrade. There are several such, but they have all proved unstable physically or chemically on life test. If such an improved heater is discovered, it will probably be from the products of the electric furnace.

One development which has come with the new lighting systems is that of maintenance by specialists connected with the factory or agencies. This is a sign that the best results are no longer to be expected from the "fool-proof construction," but that increased efficiency means increased intricacy and delicacy beyond the ability of the layman to manage, but cheaper for him to have maintained for him, than the old systems were to manage himself. The existence of the maintenance department will be a great relief to the development engineer and materially assist him in the solution of some of his problems, one of which is to secure an accurate record of the service that central stations really give their customers and effect a reform in the variation of voltage at the lamp between light load and heavy load, so that "constant potential" may come to be something more than a misnomer for a system.

Taking up now the old stand-by systems, the arc and incandescent, the problems are not all solved and some of them have been taken from the shelf, dusted and wound up as a counter attraction to the new-fangled systems.

The problem of making a small arc lamp has been revived abroad, doubtless due to the advent of the Nernst lamp, of about one hundred and fifty candle-power. In this country the problem of better distribution has been taken up and

a lamp developed with a very large corrugated reflector. This shows clearly the lengths of which the arc lamp engineer is forced to go because of the unwieldly size of his unit, and that the development of the arc lamp into smaller candle-powers of good efficiency should be attempted. It constitutes the chief problem presenting any considerable hope for solution.

The incandescent lamp has as its chief problem the manufacture of the filament, which has never been brought to a state of excellence comparable to the drawing of wire. The nature of carbon is such that it has no normal specific resistance. The density of carbon increases as the temperature to which it is subjected increases. The specific resistance decreases as the density increases, therefore the treatment process if applied to a core which is not uniform in diameter and therefore not evenly hot results in a deposit of carbon more dense upon the hotter portions and less dense and conducting on the cooler portions.

When wear begins the density differences begin to play a rôle, in all probability, the denser carbons wearing more slowly. In this way the treatment on the thicker parts of the core, we may assume, wears away faster and the core is there exposed first, other things being equal. In filaments, as at present made, the specific resistance of the core carbon is much greater than that of the treatment, and thus the filament having locally lost its treatment gets a spot where the core must carry the full current of the lamp. This gives a spot in series with the relatively high conductivity of the rest of the filament, and the result is that the voltage across the bare spot is abnormally high to force the current across, while the voltage on the rest of the filament sinks in consequence. It is therefore of the utmost importance to have the core uniform in diameter from end to end and itself as dense as possible. Nevertheless, the diameter of the core is usually not very uniform, the treatment being relied upon to equalize everything, which as we have seen it does in a way of its own by depositing carbon which is more relatively soft and easily destroyed where it is thin. It might be thought that a very thick treatment on a very thin core would be a step in the right direction, but this seems to introduce difficulties of manufacture which are too serious to warrant such a process.

The problem thus appears to be to make fibre which shall be uniformly dense throughout and of exactly uniform diameter, like a drawn metallic wire, so that when carbonized it shall retain these qualities of uniformity and take an evenly thick, evenly dense treatment and so that two filaments shall be alike before treatment and after treatment, instead of as now different before treatment, different in treatment and only superficially alike in the sum of core and treatment; a similarity which soon disappears when wear begins. The use of other substances than carbon, notably osmium or carbon mixed with this or that either chemically or physically, or at least so in the patent claim, has resulted in nothing dangerous to the continuance of the carbon filament, nor does it appear likely to, as osmium has only one good quality as a filament high efficiency, but is defective in strength, low in resistance and enormously expensive. Mixed, coated and carbide filaments are as yet either chemically unstable, due to the reducing power of carbon, or break down physically, due to differences in expansion of various materials, or they are brittle, or subject to slow dissociation at high temperatures with the formation of graphite in the case of carbides.

All incandescent lamp factories occasionally make lamps which are much superior to their average quality or to anything they can certainly produce, but these are the Will o' the Wisps that point ever onward to new problems.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

JOINT MEETING AT CHICAGO, ILL., WITH THE INSTITUTION OF MECHANICAL ENGINEERS, OF GREAT BRITAIN, MAY 31 TO JUNE 3, 1904.

A joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, of Great Britain, will be held in Chicago, Ill., May 31 to June 3, inclusive. The headquarters will be at the Auditorium Hotel.

Thursday afternoon, May 31, will be left free for assembly of members, and for visits to points of interest throughout the city.

On Tuesday evening, in the music hall of the Fine Arts Building, at 8.30 o'clock, the delegates will be welcomed by Mayor Carter H. Harrison, the response to be made by Mr. Ambrose Swasey, president of the American Society of Mechanical Engineers, and Mr. J. Hartley Wicksteed, president of the Institution of Mechanical Engineers.

After the meeting an informal reception will be held for the members, visitors and ladies in the main parlors of the Auditorium Hotel.

At ten o'clock, Wednesday morning, on the ninth floor of the Auditorium Hotel, there will be a business session for the report of tellers and committees and general business. The following professional papers will be taken up:

"The Wage Problem," Harrington Emerson.

"Some Recent Examples of Destructors for Town Refuse," George Watson.

"Refuse Destruction by Burning, and the Utilization of Heat Generated," C. Newton Russell.

On Wednesday morning the visiting ladies will be given a tally-ho drive through the boulevards and south parks, luncheon to be served at Jackson Park. The Field Columbian Museum will be visited after luncheon, and a joint excursion with the members will be made to the works of the Illinois Steel Company, at South Chicago.

Wednesday, 8.30 P. M., in the music hall of the Fine Arts Building, the following papers will be read and discussed:

"Some Theoretical and Practical Considerations in Steam Turbine Works," F. Hodgkinson.

"The De Laval Steam Turbine," E. S. Lea and E. Meden.

"The Curtis Steam Turbine," W. L. R. Emmet.

"Different Application of Steam Turbines," A. Rateau.

"The Potential Efficiency of Prime Movers," C. V. Kerr.

Thursday, 9.30 A M., at the same place, professional papers will be continued, as follows:

"Power Plant of the Tall Office Building," J. H. Wells.

"Power Plant of Tall Office Buildings." R. P. Bolton.

"Middlesbrough Docks Electric and Hydraulic Power Plant," Vincent L. Raven.

"Use of Superheated Steam and Reheaters in Compound Engines of Large Size," Lionel S. Marks.

"Commercial Gas Engine Testing and Proposed Standard of Comparison," Wm. P. Flint.

At 10 A. M., Thursday, the ladies will visit Marshall Field & Company's retail store, where luncheon will be served in the tea room at 12.30 o'clock.

On Thursday afternoon excursions will be made to the Fisk street station of the Commonwealth Electric Company, as guests of the Chicago Edison Company,

and to the stock yards and packing houses as guests of Swift & Company.

Thursday evening, at nine o'clock, the local members of the Society of Mechanical Engineers will tender a reception to the officers and members of the two societies and the ladies, at the Art Institute.

At nine A. M., Friday, the ladies will drive through Lincoln, Humboldt and Garfield parks, to the Lewis Institute, where they will join the gentlemen at luncheon, at twelve o'clock.

At 9.30 A. M., Friday, the members will convene at Lewis Institute for reading and discussion of the following papers:

"Cast-Iron Composition, Strength and Specifications," Wm. J. Keep.

"The Effects of Strain and of Annealing," Wm. Campbell.

"Experiments with a Lathe-Tool Dynamometer," J. T. Nicolson.

"Road Tests of Consolidation Freight Locomotives," E. A. Hitchcock.

"Locomotive Testing Plants."

Members and guests will visit, Friday afternoon, the clearing yards of the Chicago Union Transfer Railway Company and the Drainage Canal. On Friday evening the local members will tender a concert by the Thomas orchestra, in the Auditorium Treatre, to the two societies.

BOOK REVIEW.

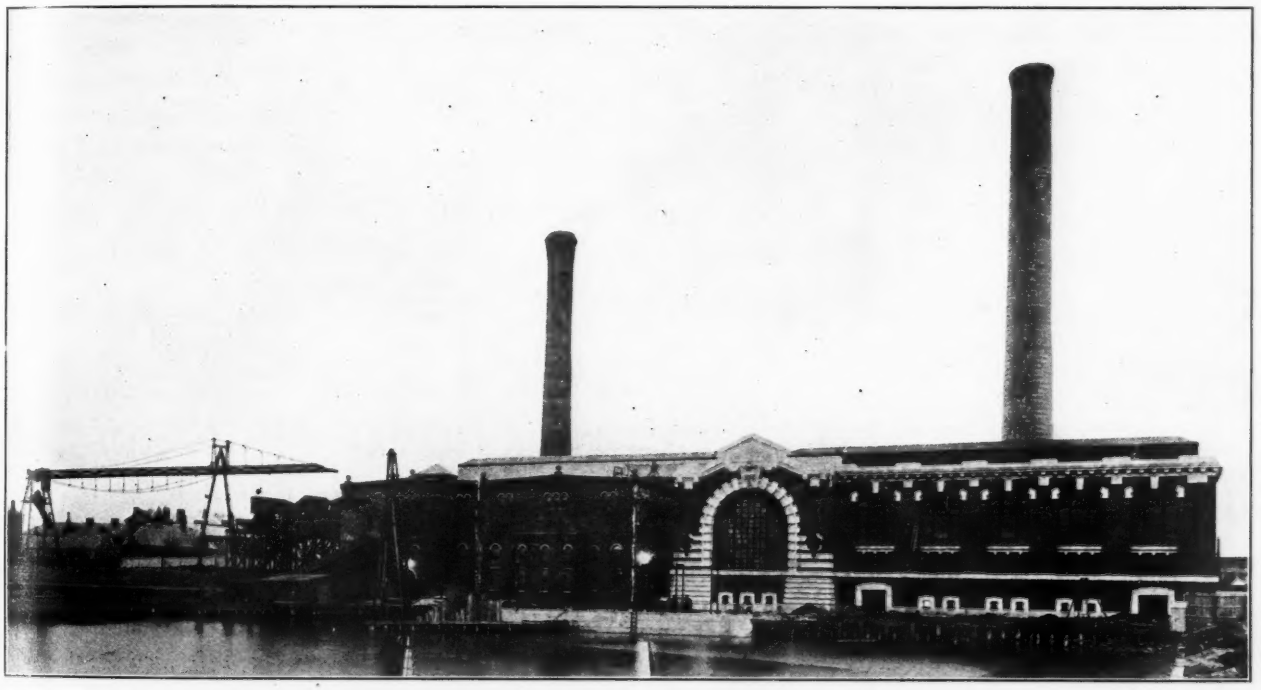
"Notes on Electric Railway Economics and Preliminary Engineering." W. C. Gotshall. New York. McGraw Publishing Company. Cloth. 252 pages. 5¾ by 9 inches. 44 cuts and diagrams, 9 plates. Supplied by the ELECTRICAL REVIEW at $2.

This work, as is stated in the preface, is an amplification of some lectures delivered at Lehigh University, which were partly based on the engineering work done by Mr. Gotshall in preparing plans for the New York & Port Chester Railway. Chapter i is introductory. In it, among other things, are discussed the relationship between the engineer and the investors employing him; and the order in which the engineering work should be carried out. Chapter ii, on preliminary office determinations, discusses the method by which rough preliminary estimates are made to determine the prospective income. This consists in the use of statistics relating to other roads of similar character, assisted by good judgment and experience. Chapter iii is on preliminary field survey. Under this head come the usual preliminary investigations that are made, to which is added some advice as to the habits and necessary discretion on the part of the engineer—good advice, but surely not needed by an engineer of sufficient mental equipment and experience to be in charge of such important work. Chapter iv, on detailed office investigation of track location, considers the subjects indicated in the title. In this chapter the author insists on either a double-track road or none. He says: "single-track railroads have been and are the cause of the major portion of railroad casualties and receiverships. If the prospective business will not support the small relative additional cost of another track, it is generally not worth going after." This statement is hardly borne out by the facts. There are small single-track roads in this country that pay a reasonable dividend on the investment, which if double-tracked would show scarcely any percentage on the increased amount of stock and bonds. There is also some good advice that should not be required by an experienced engineer in this chapter. Chapter v, on determination of schedules and equipment, is good indeed, and covers the subject well. The graphical method of laying out schedules and passing points are clearly set forth. Energy consumption and cost of construction are also considered. Chapter vi, on estimate of earnings, shows the way in which the traveling population and the probable expenditure for transportation per capita may be determined. The methods all appear sound except the one which advises the counting of passengers carried by stages or other vehicles in those regions where no other means of transportation exist. This is a manifest absurdity. Chapter vii, on estimate of probable operating expenses, is a clear and logical exposition of the way to compute the working costs of a railway. It is particularly noteworthy in that the author has pointed out the error of estimating the operating expenses as a percentage of the gross receipts. Each railway has its own expenses that are fixed by many local conditions, and the habit of arbitrarily fixing the cost of operation at an assumed percentage of the estimated gross receipts has been too long persisted in. Mr. Gotshall shows the proper method of arriving at the probable cost of operation based on data, much of which is independent of the assumed yearly receipts. Chapter viii covers the final survey and considers the final location of the line with reference to all the data accumulated, altering the preliminary route to bring about a better relation between it, the run sheets and the electrical distribution system—good so far as it goes, but somewhat incomplete. Chapter ix is on track construction and superstructure. In this are discussed the details of track, block signals, concrete arches for viaduct spans and data on concrete. Chapter x, on overhead or third-rail construction, compares the relative costs and advantages of the trolley and the third rail. Different kinds of contact shoes are described and there are four good diagrams with dimensions, showing overhead line construction. Chapter xi, on power stations, considers the question of alternating and direct-current distribution, and shows how the kilowatt capacity for a given railway is computed. Some useful data are given in this connection. The rest of the chapter, on location of power station, division of units and general design, shows simply the usual well-known practice. Chapter xii is on storage batteries and shows the advantages of batteries as auxiliaries. Chapter xiii discusses motor equipment and rolling stock. This is one of the best chapters in the book. In a comparatively short space Mr. Gotshall has gone over the subjects of speed-time, distance-time and energy consumption curves; train resistance, and gives comparisons between the amounts of energy required at different schedule speeds to propel a car over a given distance. There are also some good practical remarks on car bodies in this chapter. It is unfortunate that the heating of car motors and the relative sizes for various accelerations are not fully taken up, though the author may consider this as outside the scope of his work. The remaining five chapters are xiv, right of way; xv, preparation of specifications; xvi, the construction period; xvii, organization of the operating department, and xviii, economic considerations determining the magnitude and details of a proposed road. Two appendices add to the value of the treatise. One is a copy of the specifications prepared for the New York & Port Chester Railway; the other is a list of the most important articles that have appeared in the technical journals relating to subjects discussed in the book. The work is a creditable one viewed as a reprint of a series of lectures, and should be of much assistance to the young engineer just entering into railway work. There are also reliable information and data which are useful to the experienced engineer if the obvious and elementary portions do not tempt him to lay it down before he finds the real meat, which is there. Its greatest value lies in the fact that it is the publication of some of the methods and data used in working out a great interurban railway system, and therefore represents practical engineering; distinguishing it from an academic compilation.

The New Generating Station of the Edison Electric Illuminating Company.

Description of the Steam Turbine Plant on L Street, South Boston, Mass., and Its Relation to the Edison Company's System.

THE new power-house now being erected by the Edison Electric Illuminating Company of Boston, Mass., on L street, South Boston, presents many interesting features. This will be one of the first large generating stations equipped with the steam turbine, a fact which called for the solution of many new problems, and, at the same time, offered opportunities for the exercise of much engineering ability, in order that the full possibilities of this prime mover—which, although of an old type, has only in recent years been developed to the point where central station engineers have seen fit to adopt it—might be realized. The new features in the design of this station will be brought out later in the description of the plant.



THE POWER-HOUSE OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.

To understand the general relation of the new station to the entire Edison system of Boston, it will be necessary to describe briefly the present condition of the service in and around Boston.

In the summer of 1902 the Edison Electric Illuminating Company absorbed the Boston Electric Light Company, thereby coming into possession of the comparatively new generating station at L street, built by the latter company in 1898. This station contains six 1,500-kilowatt, direct-connected generating units, driven by vertical, cross-compound, condensing engines, and generating three-phase current at 2,300 volts. The energy is transmitted from this point by underground lines for power and light. The station is most advantageously situated. It is on the side of the harbor, not far from the business centre of the city. Land is not excessively expensive there, and the problems of obtaining coal and water for condensing purposes were easily solved. The location is admirably adapted for a generating station, distributing energy to the outlying sections now under the control of the Edison company, and, at he same time, for supplementing the generating stations which supply the city of Boston.

The Edison system in Boston proper is a three-wire, 230-volt, direct-current system, fed from four generating stations, including the L street station and a number of substations. But the growth of the company has led it outside of the city proper, so that it now controls a number of townships, some of them having their own small stations, and others which were fed from these stations. The greater number of these townships lie almost west of the city proper, but there are several to the northwest. The new L street station, when completed, will supply energy for nearly all of these townships. Some of them are already supplied from the L street station, the local power-house being shut down or converted into a substation. In others, the local power-houses are being retained as auxiliaries, though they have been reenforced by transformers and will be connected to the L street station.

Under these conditions, a large high-voltage generating station was desirable, enabling all the economies of such a station to be realized, and it was decided to secure this by adding to the old L street station, which was already overloaded. The contrast between this old station, built only six years ago, and illustrating the highest development in power-station design at that time, and the new demonstrates most forcibly the rapid progress in central station engineering. However, the old station is not to be abandoned, though the two types of units differ so greatly from the new. It will be operated in parallel with the new, the two generating rooms being controlled

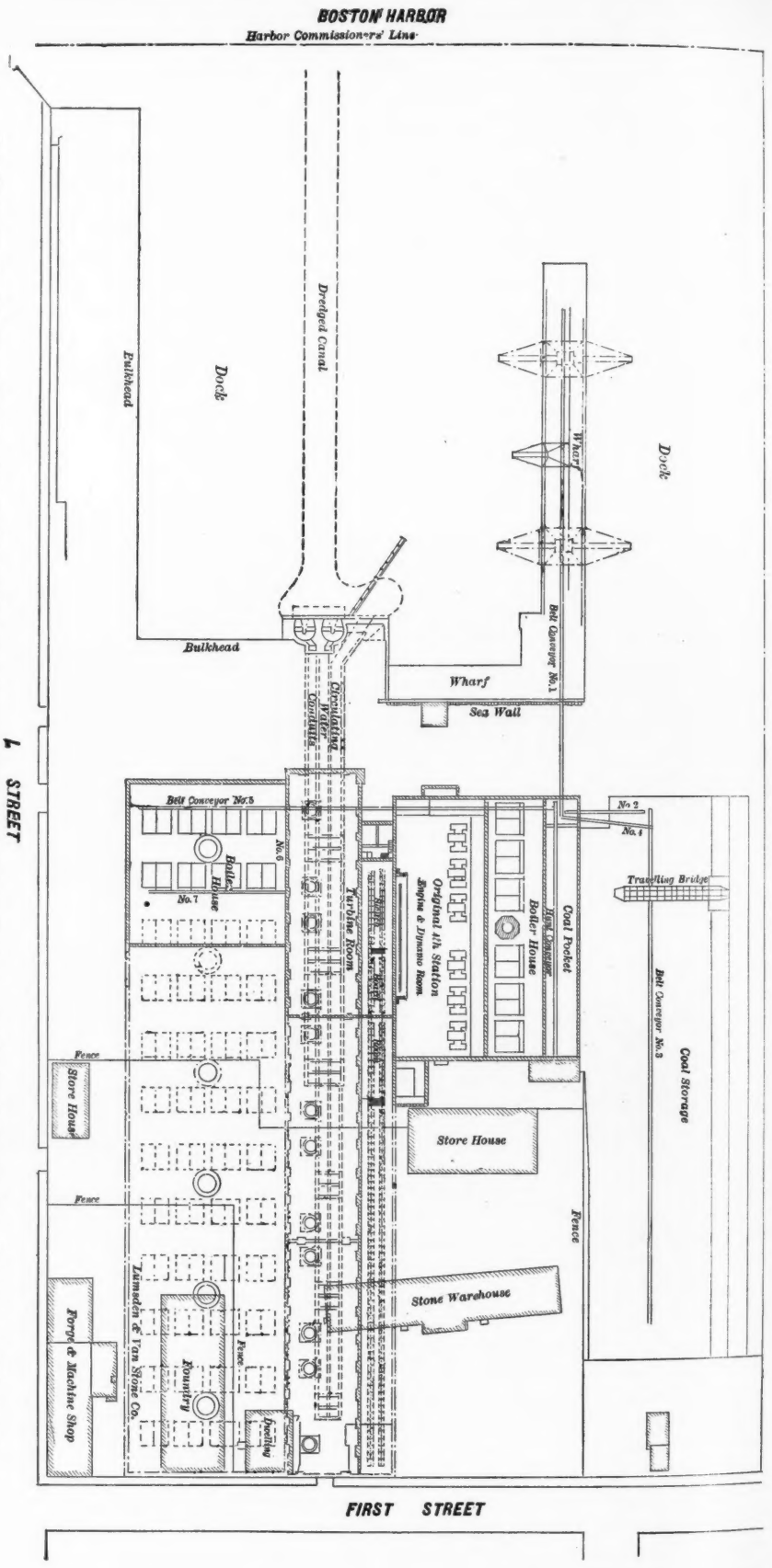
from the same operating room; but, aside from the connections at the bus-bars, the old and new stations will be quite independent.

The front of the old L street power-house faces north on the harbor. The new power-house will face in the same direction, being separated from the old by the switch house—a building about thirty feet wide. The building is of brick, cut granite and terra-cotta. When completed, it will be about 650 feet long and 250 feet broad. The design, architecturally, is fine, and well in keeping with the purposes for which the building is erected. The approach will be on L street, along the front of the station, and this space will be converted into a handsome park.

The relation between the two stations will be made clear from a study of the accompanying plan. In the centre of this is seen the old station, marked "Original 4th station," the other three generating stations, as mentioned above, being located in the city of Boston proper. Below the old station is shown the new switchboard room, the turbine room and the boiler house. The section shown in solid lines on the left represents the building which has just been erected. On the right, future extensions are shown in dotted lines. The Edison company owns all of the property bounded by L street on the west, East First street on the south, the eastern boundary of the lot marked "coal storage" on the east, and the harbor commissioners' line on the north. The ultimate capacity of the new station—or rather stations, since each addition will be treated as an independent power-house—will be 60,000 kilowatts. For this there is ample space, and no crowding of any part of the station will be necessary.

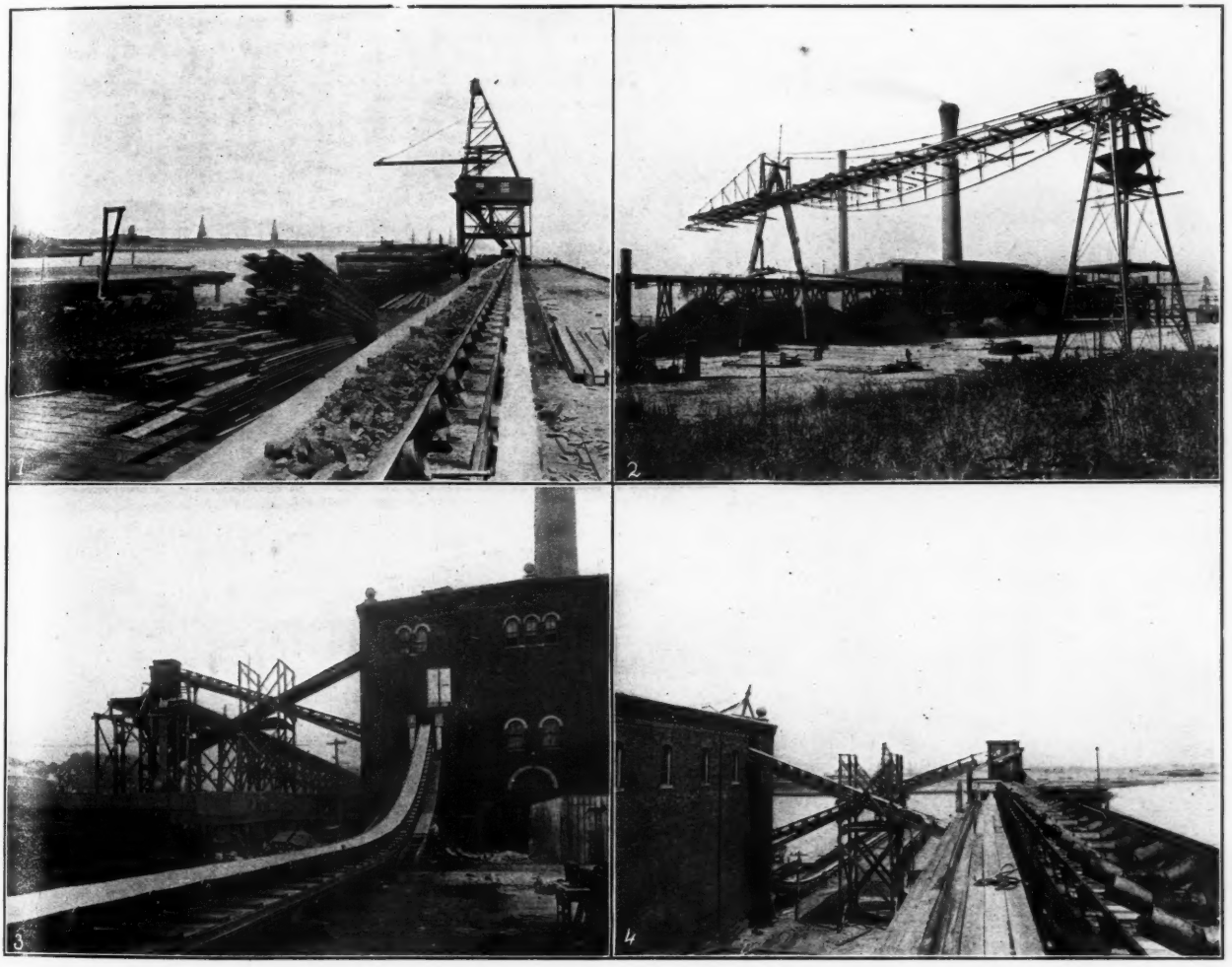
To provide coal storage for this enormous power-house, the plot of ground on the east has been secured. This is a section of the old Boston asylum ground, and, when secured, had a large building on it, which was torn down and the ground graded. It was merely leveled off, the high ground at the south being cut down, and a fill sixteen feet high formed on the north. The present area of this storage yard is indicated in the plan, but this can be extended about 125 feet at each end. Its present capacity is from 60,000 to 70,000 tons, though the ultimate capacity will be 100,000 tons.

The coal-handling system is indicated in the plan. The wharf has been reenforced, and berths dredged on each side, affording room for two vessels. The plan shows three coal-handling towers. At present there is but one—the smaller one—which unloaded vessels for the original station. This tower requires two men to operate it. It has a one-ton bucket, making about one trip a minute, and is



THE PLAN OF THE L STREET STATION OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON, AND ARRANGEMENT OF COAL SERVICE AND WHARFAGE.

operated electrically. A second tower is being erected, and a third will be added as the extensions of the power-house require. These new towers will be able to take coal from either side of the wharf, and each will require but one man to operate them. The capacity of the bucket will be one and one-half tons, making three trips per minute. This will give a coal-handling capacity for the two towers of about five and one-half tons a minute. The new towers are operated electro-hydraulically.



Coal-Handling Apparatus at the L Street Station of the Edison Electric Illuminating Company of Boston.

The coal for the original power-house was carried from the wharf in a Hunt conveyer with a capacity of forty tons per hour. This conveyer ran from the wharf and discharged coal into the coal-pockets placed just next to the boiler house. This conveyer was too small for the combined stations, so that it was cut off, only the section in the coal-pockets being retained. The line running along the wharf was replaced by a belt furnished by the Robins Conveying Belt Company, of New York city. This belt is thirty-six inches wide and will handle one ton per hour for each foot of speed. The normal speed is from 400 to 500 feet per minute, though it can be run up to 700 feet per minute, thus enabling vessels to be unloaded with celerity.

The coal which is delivered by this belt—indicated as conveyer No. 1—is received by conveyer No. 2. It should be said that all the coal conveyers, except the Hunt conveyer just mentioned, are of the Robins type. Belt No. 2 delivers the coal to conveyer No. 3, which dumps it at any point of the storage yard lying beneath it, the conveyer being erected on a thirty-foot trestle. From this point coal is picked up by the traveling bridge, which is of the Brown Hoisting Machinery Company's manufacture, and distributed over the entire field. This bridge is operated by one man, who controls its movements along the yard and the movements of the buckets.

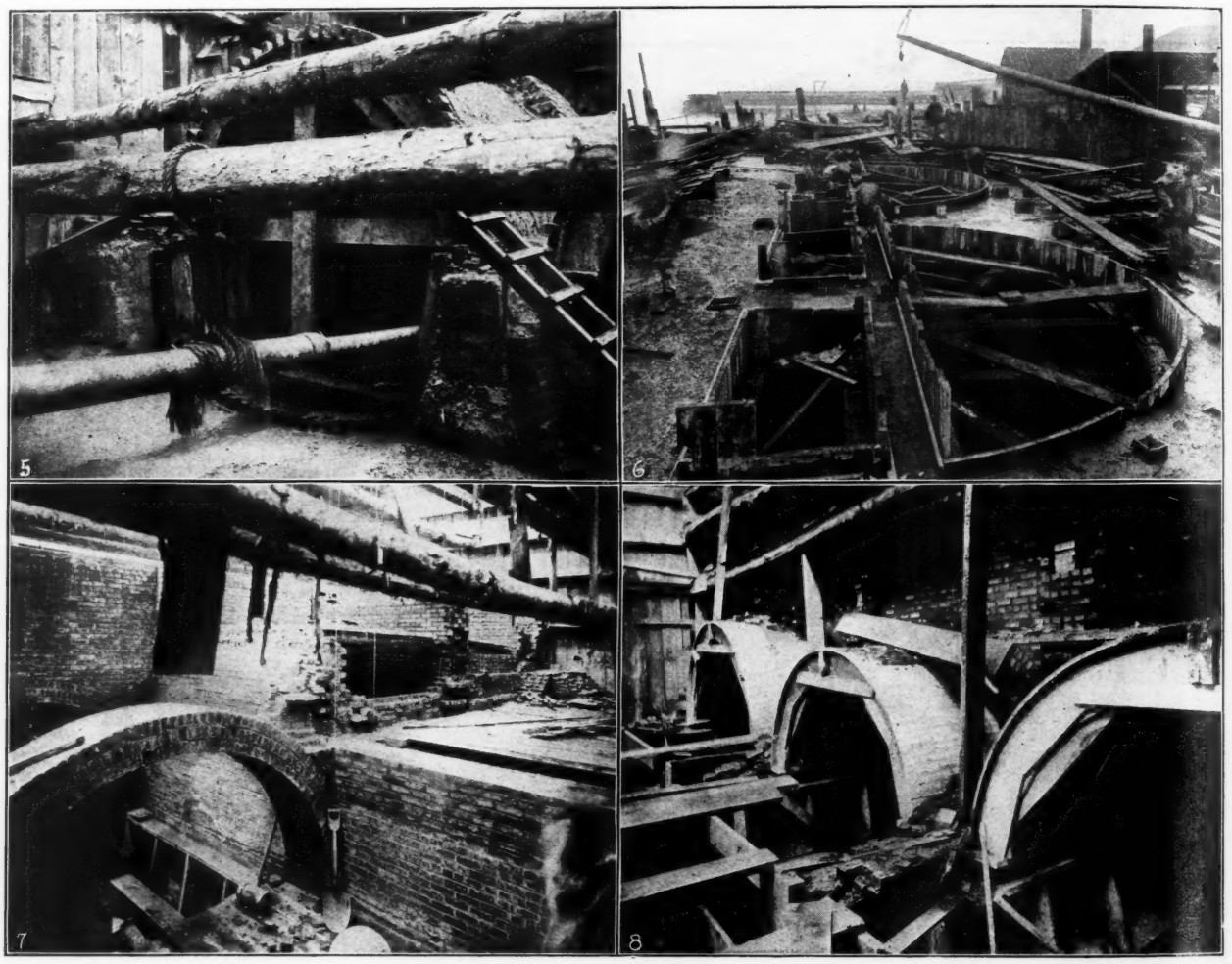
When it is desired to transfer coal from the yard to either of the power-houses, it is raised from the yard by means of the traveling bridge and loaded on to conveyer No. 3, which, for this purpose, is run in the opposite direction. This conveyer delivers the coal to conveyer No. 4, from which it can be transferred to the Hunt conveyer for the old boiler house, or to conveyer No. 5, which is twenty inches wide, having a capacity of 125 tons per hour, and carries coal to the new boiler house. No. 5 distributes the coal in the coal pockets of the first line of boilers, or transfers it to No. 6, which, in turn, will transfer it to No. 7 and the other conveyers erected for each subsequent set of boilers, all of the latter being of the same capacity as No. 5. There will be in all seventeen conveyers. Should a vessel be unloading at a time when it is necessary to distribute coal to the boiler houses, the coal is passed from conveyer No. 1 to No. 2, then to No. 3, and from this to No. 4. On each conveyer the coal is lifted part of the way, until it reaches the roof of the power-house. The arrangement of the conveyers outside of the power-house and the bridge is shown in

the illustration of this apparatus. Conveyer No. 5, which transports the coal to the new boiler house, is placed in a monitor erected on the roofs of the two buildings. The new coal conveyers were erected by J. H. Proctor & Company, of Boston, which also built the trestle for conveyer No. 3. Before being delivered to convever No. 4, the coal is passed through a crusher located on the north end of the trestle. It may be delivered to this crusher by conveyers No. 2 or No. 3, depending upon whether it is being drawn from a vessel or the yard.

Passing next to the arrangement for obtaining condensing water, the new system is shown clearly in the plan. It consists of three conduits, two for intake and one for discharge. It is intended to install the first six turbines on the shorter of the two intake conduits, and the last six upon the longer. These two conduits have each a cross-sectional area equivalent to a diameter of eight feet. The discharge conduit—which is the upper one of the three shown in the diagram—has a cross-sectional area equivalent to a diameter of ten feet. The bottom of these conduits is thirteen feet below mean low water, so that the top is several feet below the record for the lowest tide. At the harbor end of the two intake conduits, each opens into a semi-circular basin of concrete, which, in turn, opens, by means of two gates, into a channel dredged in the harbor. There is a grillage at each gate, and a second at the openings into the harbor, well under water, so that all debris strained out of the water is easily raked up and removed. To secure an ample supply of water for condensing purposes, a channel was dredged from these intake gates out to the navigating channel in the harbor. The warm water discharged from the outflow conduit passes out in a dredged basin with sloping sides, which helps to direct it to the surface. There is also a deflecting wall of timber, which prevents the hot water from flowing around to the intake conduits. However, the latter always draw water from the bottom, while the hot water, as described, is sent to the surface.

Within the turbine room, between each pair of turbines, a set of six manholes is arranged. As mentioned, the first six turbines will draw water from the shorter conduit through the lowest set of manholes, discharging into the outflow conduit by means of the upper set. The arrangements are such, however, that in case of necessity the pipe system can be changed so that these turbines will draw water from the other intake conduit. This flexibility provides for any necessary cleaning or repairs of either of the intake conduits. As the discharge water will always be flowing outward, there will probably be no need for ever cleaning this conduit. These conduits, as well as the harbor construction, were built by E. W. Everson & Company, of Providence, R. I., and, as shown in the accompanying illustrations, are of brick with arched tops and inverted arched bottoms.

The features so far considered show no radical departure from previous designs.

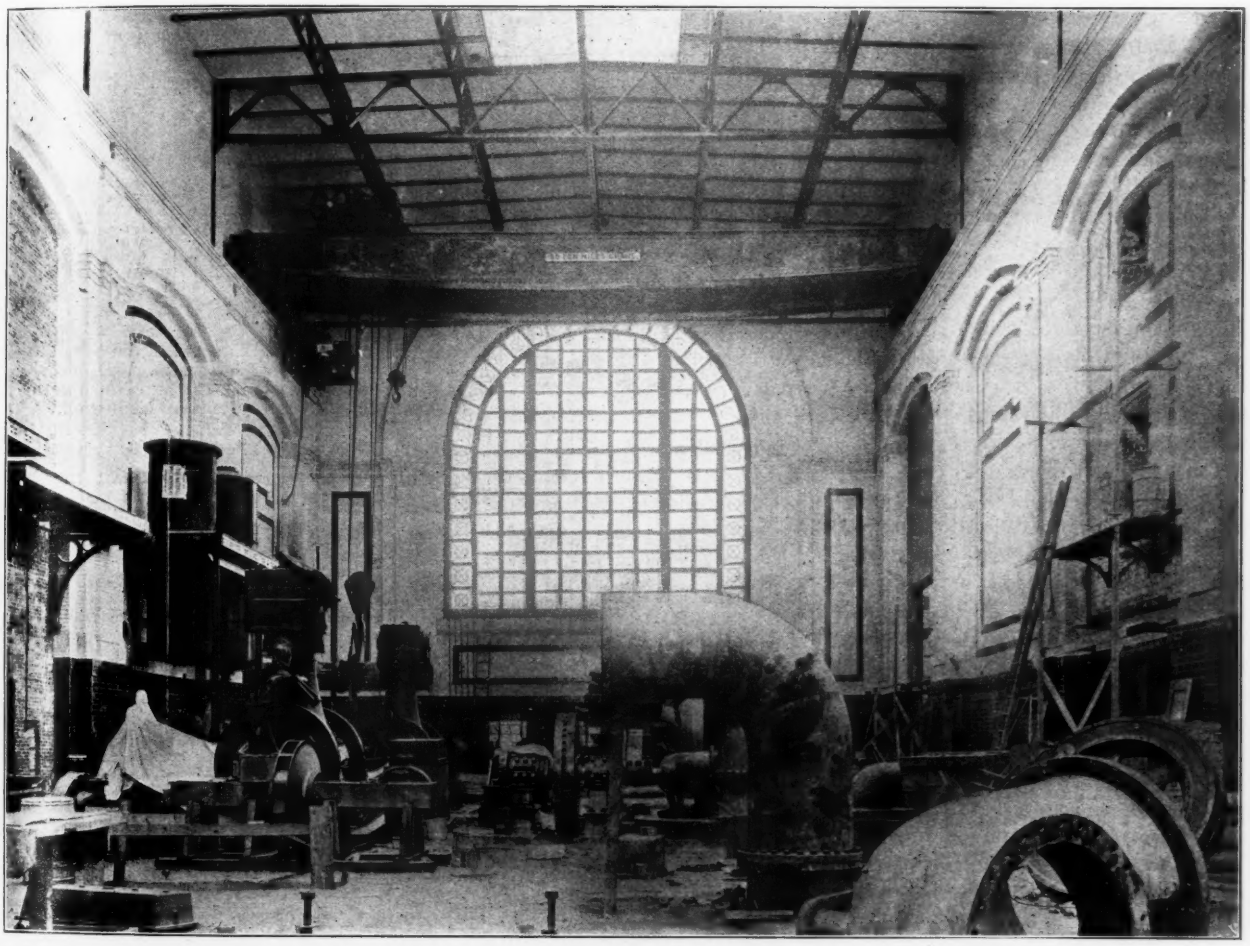


ARRANGEMENT OF SLUICES FOR INTAKE AND DISCHARGE OF CIRCULATING WATER, L STREET STATION, EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.

The coal-handling system, while it seems most elaborate, is really not complicated, and the water-circulating system is so simple, though it is constructed so as to provide for future extensions and supply sufficient water for obtaining the high vacuum so desirable for steam turbine operation.

Passing to the power-house proper, the new features in the design are at once evident. With horizontal engines, and even vertical engines of the marine type, the space required for the generating room is always greater than that necessary for the boilers. A typical arrangement was a long generating station, with a long parallel power-house, as this made the steam pipe as short as possible. But, with the adoption of the vertical type of steam turbine, conditions are reversed, and the space required for the boilers is considerably more than that needed for an equivalent turbine equipment. A new arrangement of prime mover and boilers then becomes necessary.

There is another factor which has influenced the arrangement finally adopted. With the increasing size and importance of electric generating stations breakdowns become more serious, and greater precautions must be taken to provide against a contingency. It is therefore desirable to have as much independence of the different generating sets and their boilers as possible. For this reason, some have advocated a number of entirely independent generating stations, in place of one large one. The plan adopted by the Edison company is substantially this, although the economies possible in one large generating station have not been thrown away. The ultimate generating equipment will be twelve 5,000-kilowatt turbo-alternators. These will be divided into three groups, each separated from the others, and forming an independent generating room. It is the first of these rooms which has been erected, and the initial equipment will consist of two Curtis turbines, driving 5,000-kilowatt, General Electric three-phase, sixty-cycle, 6,900-volt alternators. Each of these turbines will be supplied with steam from eight 514-horse-power Babcock & Wilcox boilers, arranged in four pairs. While the long boiler room will be parallel to the turbine room it is seen that each set of eight boilers is arranged across this room. These sets are to be grouped in pairs, with a chimney erected between. The present installation consists of two sets of eight, and the division wall for the independent boiler rooms allows for a third set, it being convenient to divide the boiler room into four independent sections. The turbine room, as has been explained, is divided into three parts.



TURBINE ROOM OF L STREET STATION, EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.

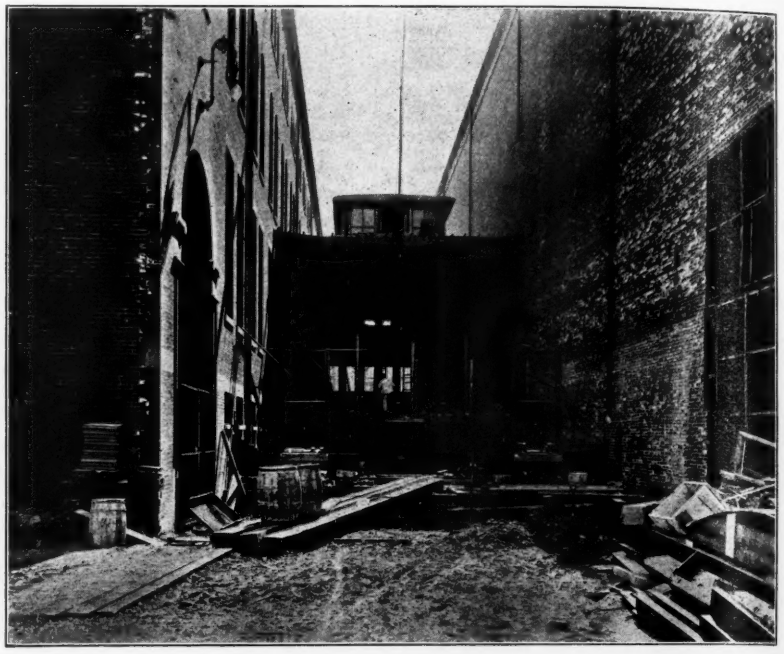
The boilers are set on the second floor of the boiler house, the first floor being used for the ash and pipe rooms. The floor of the boiler house is of terra-cotta arches and concrete. As explained previously, coal is delivered by the belt conveyers to the coal hoppers above. From here it passes down through chutes to the boilers, and is fed to the Roney stokers, which are driven by General Electric motors. The ashes are discharged into hoppers below, dumped into tip carts, and drawn off to be dumped. There was no necessity here

for ash conveyers, as these carts, drawn by horses, form a simple and efficient method of carrying out the ashes and dumping them on the low ground around the power-house, which is to be filled. When the fill has been completed, the carts or some form of industrial railway will be equally efficient in discharging ashes to barges, which will carry them out to sea.

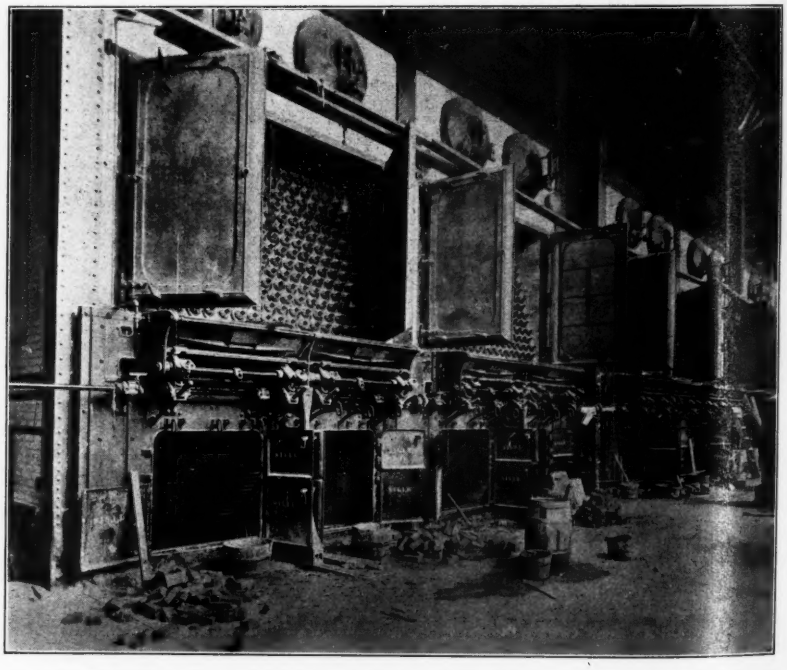
The air for combustion is drawn into the furnace from the ash room, an arrangement which allows the boiler room to be kept comfortable even in the coldest weather. The products of combustion are carried out from each boiler in a flue, these uniting to form the main flue to the chimney. The boiler rooms are well lighted by monitors on the roof, except in the case of the end room, where the windows furnish sufficient illumination. Each boiler is supplied with a Babcock & Wilcox superheater. Economizers were not thought necessary in this station.

Steam is led out from each boiler by a six-inch main, each pair of which terminate in an eight-inch main which drops vertically on the side nearest the turbine, passing down through the boiler-room floor. Here the pipe runs horizontally in a pipe room, which is walled off from the ash room. As each pair of six-inch mains joins the horizontal line, the size is increased first to eight, to twelve and then to fifteen inches, the latter being the diameter of the pipe which conducts the steam to the turbine. These pipes were all installed by the Lumsden & Van Stone Company, of Boston, and are fitted with the Van Stone flanged joint. Thus, each set of boilers is intended to be independent of all other sets, and to furnish steam to one turbine only. There is, however, a tie connection between adjacent steam mains, which is taken off just before the pipe passes from the pipe room into the turbine room, which may be used in emergencies.

Each set of boilers has its own feed-water pump, feed-water heater and hot well, but all of this apparatus is placed in the turbine room, there being no auxiliary machinery in the boiler room, except the emergency feed-water injectors and the motors for operating the stokers. The feed-water pumps are of the four-plunger Worthington type, with a capacity of 18,500 gallons of water per hour, at a very moderate speed. They are placed on the floor of the turbine room, close to the boiler-room floor. The feed-water heater is placed directly above the pump, and suspended from the boiler-room wall on a gallery. This apparatus has been supplied by the National Pipe Bending Company, of New Haven, Ct. The hot well is also suspended from this gallery, and is close to the heater. The feed-water system for each set of boilers is independent of the others, though there is a tie between them. There will also be four main feed pumps in each generating room, with a fifth for reserve.



REAR VIEW OF SWITCH HOUSE (UNDER CONSTRUCTION) BETWEEN OLD AND NEW SECTIONS OF L STREET STATION, EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.

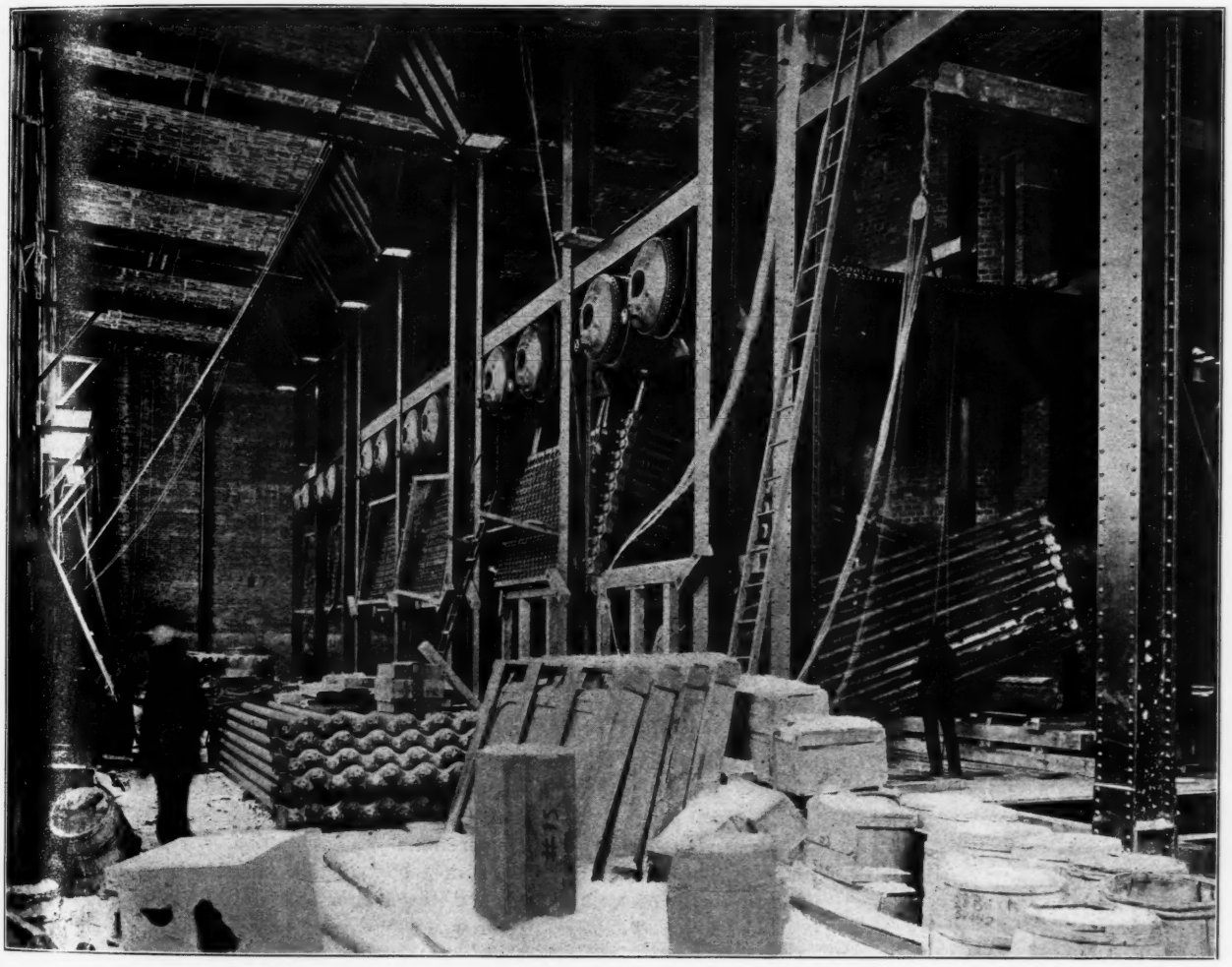


BOILER PLANT (UNDER CONSTRUCTION) SHOWING MECHANICAL STOKERS IN POSITION, L STREET STATION, EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.

The steam pipe, which is below the boiler-room floor, is above the floor of the turbine room. This length of pipe is, however, quite short. The open air exhaust, which will be used when the condenser is not in operation, is also above the turbine-room floor, but it is carried horizontally through the boiler-room wall, where it raises vertically, then turns horizontally to reach the exhaust head, furnished by the B. F. Sturtevant Company, Boston, Mass.

The turbine room is large and will not appear at all crowded when all the machinery is in place. It is about 220 long, 64 feet wide and 60 feet high, and is

lighted by large arched windows at the ends, and by a monitor on the roof. The walls have been ornamented by the Grueby Faience Company, of Boston, with tiles up to the height of the traveling crane, and above this point with enamel brick. The traveling crane, supplied by the Niles-Bement-Pond Company, of New York city, has a capacity of fifty tons. In this handsome room will be gathered al the machinery, except the electrical apparatus connected with the switchboard and the stoker motors previously mentioned. There will be no galleries running around the room, but there will be observation galleries opening from the switch-house and from the boiler room. The turbines will be placed to one side of the centre, being nearer to the boiler-room wall than to the other. Practically all of the auxiliary apparatus will be at the floor level, though one or two pumps will be placed in open pits below this floor. The general appearance of the turbine units is well known. This is of the vertical type, with the generator placed above the turbine, and with the condenser below the turbine, contained within the bed-plate of the latter. The stairways for reaching the various parts of these units are arranged to conform to the general design of the power-house. The first flight leads from the floor up to the stage where the turbine is placed. From here a flight leads to the galleries, where the feed-water heater and the hot well are suspended. From this gallery there is a door leading into the boiler house. A third flight of stairs leads from this gallery to the top of the generator, where the governor is placed. By this arrangement the engineer can go directly to any point, without having to retrace his steps by going down one flight of stairs and up a second.

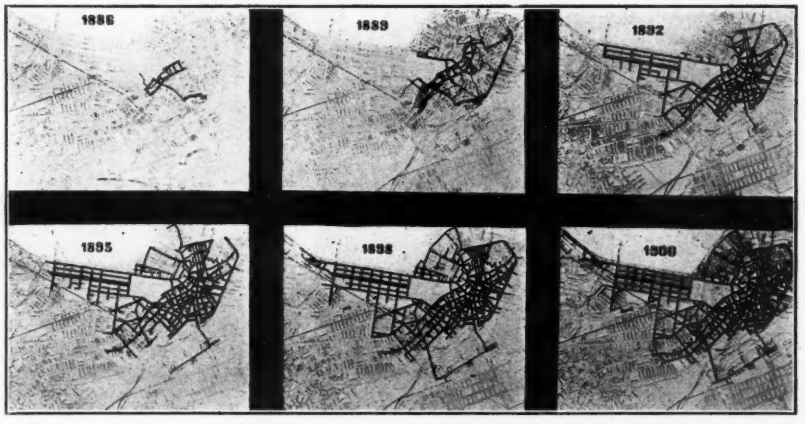


Boiler Setting under Construction, L Street Station, Edison Electric Illuminating Company of Boston.

Around each turbine is grouped its auxiliary apparatus. On the side nearest the switchboard room is the pump for circulating the condensing water. This, as has been explained, draws cold water from one of the intake conduits and discharges the heated water into the discharge conduit. Both intake and outlet pipes are carried well below the lowest tide level, so that it will not be necessary for this pump to lift the water. It will only have to circulate it, overcoming the friction of the pipes. The pump, which is furnished by Henry R. Worthington, of New York city, is of the volute type, and is driven by a horizontal Fleming engine, supplied by the Harrisburg Foundry and Machine Company, of Harrisburg, Pa. The dry vacuum pump is a vertical air pump driven by a horizontal steam cylinder. This pump is shown in the diagram between the turbine and the manholes leading into the conduits, and between the circulating pump and the boiler-room wall. The wet vacuum pump is a rotary pump, driven by an electric motor. This will be placed below the engine-room floor in one of the open pits. These two pumps, as well as the oil pumps and the feed-water pump, were furnished by Henry R. Worthington. The oil pump for furnishing oil under pressure, which is supplied to the step bearings of the turbine, will also be on the turbine room floor in

this vault. The oil accumulator furnished by R. D. Wood & Company, of Philadelphia, will be set close to the turbine on the side opposite to the pumps. The grouping of all the machinery for each turbine is practically the same, except for the arrangements being reversed. The floor of this room will be unbroken, covered with tiles, and the only openings will be the stairs down to the open pits, the pits themselves, and the covers for the tunnel manholes. All the piping, except the steam and exhaust pipe described above, will be out of sight, but perfectly accessible, and the electrical conductors will also be carried from the turbine room to the switchboard house through ducts under the engine-room floor.

The system of open pits under the engine-room floor is arranged to give access to the step bearings of the turbines. They are entered by a stairway placed close to each turbine. From the foot of this a passage runs diagonally to a vault, giving access to the step bearings. Beyond this vault, the passageway makes a right-angle turn and leads to the vault where the two pumps mentioned above have been placed. From this vault a passageway runs parallel to the boiler-room until it meets the corresponding vault for the next generating unit.



THE GROWTH OF THE SERVICE OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON.

In the design of the station three main divisions have been recognized—the boiler house, the turbine room, or really the machine room, and the switch house. The boiler room, as has been seen, contains only the boilers and the motors for operating the stoker. In the turbine room all other auxiliary apparatus is collected and arranged so as to make access to each piece easy. Thus, only under exceptional circumstances will it be necessary for the engineer in charge to leave the turbine room. This grouping of the machinery not only ensures reliability, but makes it possible for the engineer to have complete control of all his machinery and thus reducing the number of attendants required to a minimum.

The switch house is located between the new and the old generating rooms. The front part of this building contains the main entrance and the offices for the engineers. All employés will enter and leave the buildings through this entrance, and here will be placed the time clock. Back of these offices is the switch house proper. This has four floors, the lower containing the cable vaults, into which lead all the wire ducts, both those from the old and the new generating rooms, and the distributing vaults which lead out to the streets. A description of this system was given in the ELECTRICAL REVIEW for March 5. The new conduits were laid by G. M. Gest, of New York and Cincinnati. The floor just over the cable vaults contains the bus rooms. Here are placed the various sets of buses, arranged in fireproof compartments along the centre. Along the sides are the potential transformers, the knife switches for disconnecting the generator leads and the current transformers. Over the buses are placed the knife switches for opening all cables.

The next floor is the switch room, where are placed the electrically operated oil-break switches. There is a pair of selector switches for each cable, and a second pair for each generator lead. There is, in addition, a main generator switch. The feeders are connected to the desired bus by operating one or the other of the selector switches. To throw in a generator, first one of the selector switches is thrown, connecting the generator lead to the corresponding set of buses. This, however, leaves open the main generator switch. The generator is then synchronized with the bus-bars, and this switch is closed.

The upper floor of the switch house forms the operating room. This is lighted by a monitor in the roof, and it is entirely shut off from both generating rooms. The switchboards are arranged around the sides and ends of the room. At the end nearest the offices is the exciter board. Next to this, along the sides of the room, are, on the one side, the generator board for the old station, and, on the other, the corresponding board for the new station. Then follow the boards for the feeders. On these boards are mounted the controlling switches and the instruments. The switchboard apparatus was supplied by the General Electric Company, and typifies the highest development that has yet been reached in the design of switch houses.

When the new station is put into operation, the alternating-current switchboard in the original station will be transferred to the new room. The old switchboard at present consists of two stories. The first story, which is operated from the engine-room floor, is for the arc lights; the second, for the alternating-current system. The arc light switchboard will remain in place, and will be controlled from this room.

In a generating station of this size it is of very great importance to prevent any breakdown of the exciting system. In the original station there is a single steam-driven fifty-kilowatt exciter set used for starting purposes. There are, in addition, several motor-driven generator sets for the exciter service. In each of the new turbine rooms there will be a motor-driven exciter set placed on the floor near the switch-house wall. A storage battery equipment, which will float on the exciter system, is also being installed in the storage battery house in the rear of the older station. This exciter system will be reserved entirely for the exciting circuits and for a small number of extremely important lamps, such as that for the boiler water gauge, at important points in the engine room and in the switch house. This arrangement is for the purpose of providing against any possible contingency which might throw out the entire station. There would still be light enough from these lamps to carry out the necessary operations in rectifying the trouble and starting again.

The voltage of the new units will be 6,900. That of the old is 2,300. To tie the two generating units together when desired, transformers are required. These are placed in a small transformer house just in the rear, and entered from the old generating room. There are at present in this room three 500-kilowatt

and three 900-kilowatt transformers. Space is reserved for doubling this equipment.

The equipment of the new station is as yet incomplete. The condition about the first of this month is represented in the illustrations.

The Boston system is an extremely important one, and it is to the credit of the engineers in charge that it has always been in the forefront of power-station design. The size of the system is well indicated by the allowance for future expansion to an ultimate capacity of 60,000 kilowatts in new machinery alone. At the first of this month the Edison company was operating 642,406 incandescent lamps, 9,546 arc lamps and supplying power to motors to the extent of 23,891 horse-power. Many of these motors are in the city proper, and are operated on the outers of the three-wire system.

The president of the company is Mr. C. L. Edgar, who has been associated with it since 1877, and to whose able management much of its success is due. With him are associated the following officers, who have taken an active part in the design and construction of the new power-house: Mr. Sidney Hosmer, superintendent of construction; I. E. Moultrop, mechanical engineer; W. P. Hancock, superintendent of stations; L. L. Elden, electrical engineer.

The following is a list of the contractors who have carried out the work at the new station:

Aberthaw Construction Company, Boston, Mass., reenforced concrete in the building.

American Steel and Wire Company, Chicago, Ill., cable.

A. & J. M. Anderson, Boston, Mass., erecting oil switches.

Atlantic Works, East Boston, Mass., hot well and blowoff.

Alphons Custodis Chimney Construction Company, New York city, chimney.

A. Cast, Boston, boiler settings.

B. F. Sturtevant Company, Boston, Mass., exhaust heads for steam pipe.

Babcock & Wilcox Company, 85 Liberty street, New York city, boilers.

Bay State Dredging Company, Boston, Mass., dredging.

Blount & Lovell, Boston, Mass., stoker drives.

Brown Hoisting Machinery Company, Cleveland, Ohio, coal-handling bridge.

C. A. Claflin & Company, Boston, Mass., Lee injectors.

Chapman Valve Manufacturing Company, Indian Orchard, Mass., gate valves.

Chelmsford Foundry Company, Chelmsford, Mass., part of the ironwork in the ashroom and pipe gallery.

C. H. Crosby & Company, Boston, Mass., changed over cables from old to new conduits.

Cory Signal Company, New York, N. Y., engine and operating-room indicators.

Conduit Electric Manufacturing Company, Boston, Mass., three-phase power circuit to coal tower.

Daniel Russell & Company, ash chute dampers, weighing hoppers and coal chutes to stokers.

E. W. Everson & Company, Providence, R. I., sluiceways and harbor construction; grading at the grounds.

Eastman, Pease & Company, Boston, Mass., galleries about the machines.

Edward Kendall & Sons, Cambridge, Mass., smoke flues.

F. A. Snow, Boston, Mass., duct line work.

F. J. Hannon, Boston, Mass., grading.

G. M. Gest, 277 Broadway, New York and Cincinnati, electrical conduits.

G. W. & F. Smith Iron Company, Boston, Mass., galleries on the walls of the turbine room.

General Electric Company, Schenectady, N. Y., switches, motors for stokers, turbines, generators, transformers, instruments, etc.

Grueby Faience Company, Boston, Mass., ornamental tiling.

Harrison Safety Boiler Works, Philadelphia, Pa., Cochrane separators.

Harrisburg Foundry and Machine Company, Harrisburg, Pa., Fleming circulating engine.

Herbert S. Potter Boston, Mass., electric wiring for light and power.

Hecla Iron Works, 118 North Eleventh street, Brooklyn, N. Y., iron windows.

Henry R. Worthington, 114 Liberty street, New York city, circulating, dry and wet, vacuum, oil and feed pumps.

India-Rubber and Gutta-Percha Insulating Company, Yonkers, N. Y., Habirshaw cable.

J. H. Proctor & Company, Boston, Mass., erected belts and built the trestle for the coal conveyer.

James T. Boyd, Boston, Mass., consulting engineer.

L. Schutte & Company, Philadelphia, Pa., boiler stop, check valves, ejectors for priming circulating water pumps.

L. R. Tidd, Boston, Mass., timber work on the wharf and plank driveways.

Locke Regulator Company, Salem, Mass., damper regulators.

Lumsden & Van Stone Company, Boston, Mass., flanged pipe joints, high-pressure steam pipe, circulating water pipe, free exhaust pipe and most of the smaller piping.

National Conduit and Cable Company, New York, N. Y., cable.

National Pipe Bending Company, New Haven, Ct., feed-water heaters.

New England Structural Company, Boston, Mass., steel for building and coal conveyer.

Niles-Bement-Pond Company, 136 Liberty street, New York city, electric crane.

Pittsburg Reduction Company, Pittsburg, Pa., aluminum.

Priest, Page & Company, Boston, Mass., Howe scales.

Purdy & Henderson, New York, N. Y., consulting engineers for the architects.

R. D. Wood & Company, Philadelphia, Pa., oil accumulator.

Robins Conveying Belt Company, 13 Park row, New York, new conveying belts and coal tower.

Sargent & Lundy, Chicago, Ill., consulting engineers.

Trenton Porcelain Company, Trenton, N. J., porcelain insulators and tubes.

Walworth Manufacturing Company, Boston, Mass., city water mains, meter connections.

Westinghouse, Church, Kerr & Company, New York city, the Roney stoker and Holly system.

Whidden & Company, Boston, Mass., general contract for the entire building.

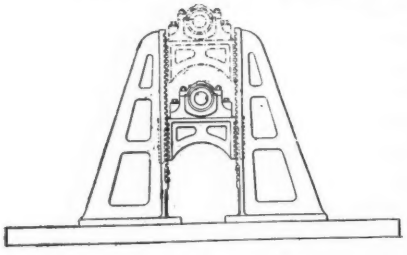
Winslow & Bigelow, Boston, Mass., architects.

A Rural Telephone Produce Exchange.

The Penn Yan (N. Y.) Telephone Company has established a rural produce exchange for the use of its patrons. There are over 200 rural subscribers connected to this exchange, and there are 200 more telephones contracted for. Manager A. M. Taylor, says the *American Telephone Journal,* conceived the idea that a general information central would be appreciated by his rural patrons; so, in accordance with this idea, he installed a large blackboard. To illustrate how this idea works, let it be supposed that a party living on the Torrey line has a horse, cow, seed or any other marketable article for sale. He calls up the produce exchange, giving the number of his telephone, and tells what he has to sell. This information is placed upon the blackboard. Now, suppose that another person, residing on the Crosby-Barrington line, wishes to purchase something of this kind, and asks the produce exchange who has horses, etc., to sell. He is given the number of the party who has such articles as have been enquired for, and then he can call and find what he wants, without making extensive trips throughout the country. Besides the rural lines, the Penn Yan exchange has over 500 telephones within the town limits. By the end of the year, from present indications, there will be 1,000 subscribers.

A New Dynamo Testing Machine.

Mr. James J. Wood, of Fort Wayne, Ind., has obtained a patent on a machine for testing dynamos. The purpose of this invention is to provide a suitable machine upon which the field magnet and armature of a dynamo may be mounted in correct relation in order that the armature may be revolved in the centre of the field for testing purposes—that is, to determine its balance and electrically test its winding while revolving in its appropriate field magnet. The machine is especially applicable with what are known as "direct-connected" dynamos or generators—that is to say, those which when set up for use are directly coupled to or built as a part of the steam engine or other source of power. In testing direct-connected generators it has been heretofore customary to block up the bearings supporting the armature shaft or a special shaft upon which the armature was hung for testing until the armature was brought to correct position to revolve in the exact centre of the field. The invention provides a very simple, effective and convenient means for accomplishing the requisite support during testing and enabling the armature bearings and field magnet to be adjusted in perfect alignment and to any variations in height that are necessary to bring them to the correct relative position. This new machine comprises means for fixedly supporting one member of the dynamo and for adjustably supporting the other member thereof on vertically adjustable supports. These supports are fastened against upright columns or pedestals, to which they may be confined at any desired elevation. The pedestals on their vertical faces are formed with transverse grooves equidistantly spaced, while the abutting faces of the supports are formed with like grooves spaced either closer together or wider apart than those of the pedestals, so that by adjusting the supports to the desired height and inserting keys in the slots formed by the grooves which coincide, the supports are firmly and securely upheld at the desired elevation. By reason of the different spacing of the respective series of grooves a vernier adjustment is secured, providing for an almost infinite number of gradations in the elevation of the supports, while enabling fastening means of adequate strength to be used.



A Machine for Testing Dynamos.

The New York Electrical Society.

The 243d meeting of the New York Electrical Society will be held at the Havemeyer Building, Columbia University, New York city, Wednesday evening, May 25. There will be a business meeting at 7.45 P. M., and at 8 o'clock, Dr. M. I. Pupin will lecture on "Selective Signaling by Electrical Resonance." Dr. Pupin will explain the principles and the essential elements of this system of transmission. These elements are: the multi-frequency alternator, the transmitter, the distributors, the resonators and the rectifiers. At the special request of the United States Patent Office commissioner, Dr. Pupin has prepared an exhibit for the pavilion of the United States Patent Office at the St. Louis Exposition, illustrating by a complete model the transmission of telegraphic messages by alternating currents of various frequencies, the receiving and the transmitting apparatus being electrically tuned to the frequencies which they are intended to receive and transmit. This exhibit will be shown at the lecture. The lecturer will discuss, at some length, the application of electrical resonances, on which the development of wireless telegraphy may so largely depend.

The following members were elected at the last meeting: J. K. Robinson, S. B. Jones, Arthur H. Bryant, J. B. McKeown, Edgar S. Barney, Geoge W. Russell, Jr., P. G. Gossler, Richard Bigelow, Basil G. Kodjbanoff, Charles R. Florence, Charles H. Stanton, John A. Secor, Lynn S. Kidney, Alfred L. Larwill, William H. Robb, A. K. Spencer and Frederic E. Town.

The Experimental Determination of the Form of Alternating Currents.

The following method for determining experimentally the form-factor of alternating-current waves is given in the London *Electrician* for May 6. The method was devised by Messrs. P. Rose and A. Kühns, of the Physikalisch-Technische Reichsanstalt:

The form-factor f is defined as the ratio of effective volts to mean volts—*i. e.*,

$$f = \frac{1}{\tau/2}\sqrt{\int_0^{\tau/2} e^2 dt} \div \frac{1}{\tau/2}\cdot\int_0^{\tau/2} e\, dt.$$

The dividend coincides with the reading of an alternating-current voltmeter, and the divisor may be obtained in the following manner. A disc of insulating material, half of whose periphery is covered by a metal segment, is rotated by the alternating-current machine, the form-factor of which is to be found. Two brushes, placed side by side, rub on the periphery of the disc. The whole arrangement acts like a switch, which makes contact during one-half of the alternating-current wave and breaks contact during the other half. In this way a pulsating continuous current is obtained, and, if this pulsating current is sent through a continuous-current voltmeter of the D'Arsonval type (having small self-induction) or through a wattmeter in the manner described below, then the reading will represent half the mean voltage of the alternating current. The form-factor, therefore, is obtained by dividing the effective volts, as read off the alternating-current voltmeter, by double the reading of the continuous-current instrument. If a wattmeter is used for this purpose, a constant continuous current is sent through the main coil, while the voltage coil is fed by the pulsating continuous current. Thus the wattmeter is converted to a voltmeter, suitable for indicating the mean of the pulsating wave sent through it. In this manner the authors determined the form-factors of various waves and found that they agreed very closely with the form-factors obtained by the aid of a planimeter.

The Eiffel Tower in Wireless Telegraphy.

A Paris correspondent of one of the London daily papers reports that wireless telegraph experiments are now being conducted from the Eiffel tower. The tower supports a copper rod 350 metres in height—that is, fifty metres higher than the tower. This forms the antenna of the station. It is thought that this high antenna will enable communication to be established at a radius of 250 miles around Paris, and consequently with some of the French seaports on the channel, and even with the French squadron out at sea. Up to the present time, messages have been exchanged only with the forts forming the outer defences of Paris.

Engineering Building Fund.

The fund which is being raised by the American Institute of Electrical Engineers as its share of the expense in securing the ground on which the new engineering building is to be erected, has been increased by several important contributions recently. Mr. E. W. Rice, of Schenectady, N. Y., has contributed $1,000; Mr. Thomas A. Edison, $5,000, and Dr. M. I. Pupin, of Columbia University, $5,000. This brings the total fund up to $60,000 at the present time.

TELEPHONE ENGINEERING—V.

BY J. C. KELSEY.

MULTI-VOLTAGE REPEATING COIL SYSTEM —THE DEVELOPMENT OF THE TRUNK CONNECTION.

Common battery double supervision service is particularly adaptable to rapid connection and disconnection of telephone subscribers entering different offices. By reason of automatic signaling, both A and B operators know the exact state of the connection. A lamp exists in the trunk at B, which tells her when her party has answered, and entirely eliminates the possibility of ringing in the subscriber's ear. Local battery service gave no indication of the growth of a connection, and even did not give a disconnect signal, except when the subscriber remembered to ring off. But in common battery trunk service, not only does the B operator know when the B party answers, but the A operator as well. She gets a signal simultaneously with B, upon disconnection, but it has been found that A alone should get the signal, and then signify to B that the trunk is no longer needed. A is the originating operator, and is therefore given control of the connection. It is her duty to see that the call is properly completed and terminated.

To accomplish this, four lamp signals are required, of which two are at A, in her ordinary cord circuit, and the other two in the B circuit. When the calling party hangs up his receiver, the answering supervisory lamp of the A cord circuit should light up. When the called party hangs up his receiver, the calling supervisory lamp of the A cord circuit should light up also. There is no forgetting to ring off, for the subscriber unconsciously gives the signal. When the called party hangs up, the A operator knows it at once, and if the calling party also hangs up, thereby giving a complete clearing out, A pulls down both plugs of her circuit, and unconsciously gives B notice to pull down her part of the connection by lighting one of her two lamps. The other lamp signifies to B that the party has answered. After doing this, it has no further function, and is removed from the future operation of the trunk for that particular connection. A comparison of local and common battery trunking shows that fifteen common battery trunks will handle the traffic that requires thirty local battery trunks.

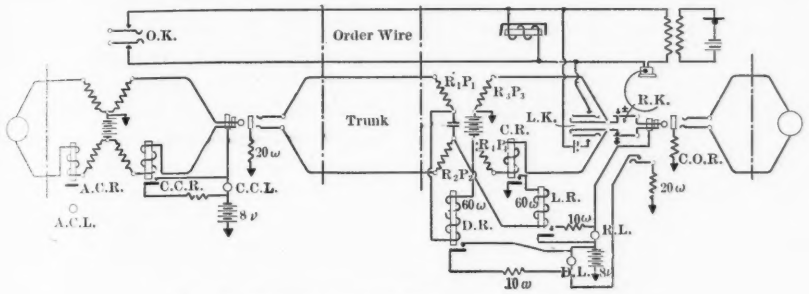


FIG. 7.—MULTI-VOLTAGE REPEATING COIL SYSTEM.

A trunk circuit may be considered as a long calling cord, too long for one operator to handle, and thereby requiring the aid of an operator in the distant exchange. The signals of the A circuit act exactly like local connection, but the B or distant operator does the ringing. The B circuit ends in a plug, ringing and listening key, and the two lamp signals. In Fig. 7 DL serves as a disconnect lamp, and also signifies that A has heard the trunk ordered and inserted the plug accordingly. As long as DL is dark, operator B can on no account disturb the connection. But when lighted, it denotes an idle trunk. Lamp RL is the ringing lamp, and signifies to B when the desired party answers.

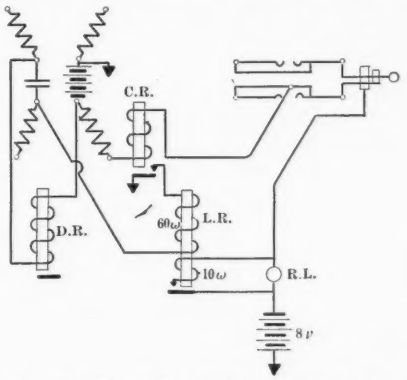


FIG. 8.—MULTI-VOLTAGE REPEATING COIL SYSTEM.

The first trunk installed with the multi-voltage system did not cause the lamp DL to remain out, after it had served its purpose. It was allowed to light again. It therefore caused A and B to get simultaneous disconnect signals, which is quite contrary to present practice. The connection is shown in Fig. 7, in which the A circuit is stripped of all its connections, except those bearing on the supervisory lamps, ACL and CCL. OK is the order key, which gives each A operator the opportunity for direct speaking with the distant B operator. The multiple of the trunk jack is in the A office, in which the tip and ring springs are connected to the trunk line, and the sleeve to ground through twenty volts, to take the place of the resistance acting as the cutoff relay winding. Otherwise, the cord supervisory lamp CCL would have no complete circuit. The trunk terminates at B in a plug. But this plug and the jack are only in inductive relation, being separated by a repeating coil. Each office supplies its own subscribers with battery current, whatever the connection.

The trunk line proper ends in the two quarters of the repeating coil, R_1P_1 and R_2P_2, the quarter windings being connected by a condenser. Were the two quarters short-circuited, the trunk line would cause battery to flow through the A supervisory relay prematurely, extinguish CCL before the proper time and thereby confuse the operating of the trunk.

The ringing lamp RL is connected between the eight-volt battery and the sleeve of the plug, being a four-volt lamp it lights at proper brightness, when the entrance of the plug passes it in series with the cutoff relay winding of twenty ohms. The disconnect lamp DL is lighted when the operator lifts the plug from its seat, closing a switch which allows eight volts of battery to flow through the lamp

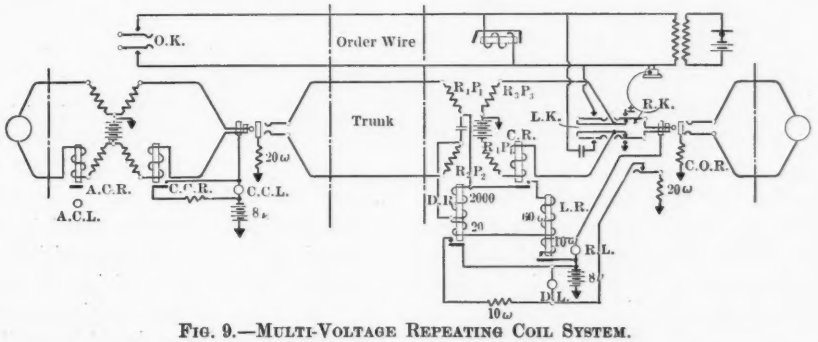


FIG. 9.—MULTI-VOLTAGE REPEATING COIL SYSTEM.

and the series resistance of twenty ohms. Relay CR is the usual non-inductive cord relay of this system. Relay DR controls lamp DL, and relay LR controls lamp RL. Both relays, when energized, place ten-ohm shunts about the lamps.

When a call is made for another office subscriber, the A operator depresses the order key OK, and notifies operator B of desired number. B assigns the trunk to be used, and at onces picks up the plug to test the jack of the called party. The test is made in the usual way, by touching the tip to the sleeve. If busy, energy is stored up in the quarter winding, more properly, the core of the entire coil, which discharges into the bridged receiver, and the bridged calling receiver. Lifting the plug from its seat causes lamp DL to light. About this moment, we may assume that A has inserted her plug into the jack of the specified trunk, to complete the connection. This act will energize relay DR, because the current flows from the B battery through relay DR over the tip side of the trunk line through the quarter of the repeating coil to ground. The relay DR darkens DL.

The act of picking up the trunk plug causes DL to light. The entrance of the A plug causes it to be extinguished, whereupon B rings on the desired line, after plugging into the jack. The act of plugging in causes the lamp RL to light. When the party answers, lamp RL darkens, because the subscriber's relay CR is actuated, and puts a ground on a circuit including relay LR, the ring side of the trunk line, the ring side of the A cord circuit through relay CCR to A battery. Relay LR being actuated, puts a shunt coil about RL, and relay CCR at A shunts CCL. Therefore, the removal of the called party's receiver gives both A and B operators a simultaneous signal.

During a talking connection, all four lamps are dark. When the calling party hangs up, ACL will light. When the called party at B hangs up, lamp CCL will light, and simultaneously, one of the lamps at B, RL. The originating operator at A, seeing both signals lighted, pulls down her part of the connection. The act of withdrawing the plug from the trunk jack opens the circuit through relay DR and over the tip side of the trunk line, allowing lamp DL to light. This is the signal for B to pull down her connection. CR governs the action of two relays, or three relays depend on action of subscriber. One relay DR is solely controlled by the A operator.

The simultaneous disconnection is a bad thing, unless the B operator waits for the proper disconnect signal. Suppose an A party calls, and the B party answers in the person of the office boy. He will hang up and call the busy office man to his extension desk telephone. The act of hanging up would cause lamps to light at A and B, CCL and RL, respectively. The A operator would not have any temptation to pull down the connection, because she only acts on two signals. But B is usually rushed, and seeing the lighted lamp RL, will jump at the conclusion that the connection is finished, and will order another connection put up on the trunk. When the office man removes his receiver, he will find no one waiting, but presently his own operator will answer him, who is blissfully unconscious of any trouble. The result is lost time, both to operating company and to that business man.

To prevent this trouble, a change was made in the trunk circuit, shown in Fig. 8. The single winding relay LR was replaced by a compound relay composed of sixty and ten-ohm windings. The sixty-ohm winding was connected just as the original LR was. But the ten-ohm shunt resistance was replaced by the ten-ohm winding of the compound relay which, when actuated, pulled up its armature, and closed the ten-ohm winding about lamp RL. When the sixty-ohm winding ceased to carry an energizing current, its armature would not release, because the current shunted from the lamp had set up a magnetism in the core of the relay, and a permanent shunt was obtained, which could only be broken by the withdrawal of the plug, which breaks the lamp circuit itself.

With this locking relay, the office boy could hang up, and B would know nothing of it. Both of her lamps are out, and RL stays out. When A withdraws her plug, lamp DL lights, which gives B a positive order to disconnect and gives no chance for error.

It is a peculiarity of this trunking system and all of the later developments, that no signals will be operated without the entrance of the A plug. The B relays can not act on the signals until the battery from A has acted upon them. Some trouble is therefore caused by the cutting in of chance line transpositions, or reversals due to the rewiring at some cable box, or cross-connecting frame. While such possibilities should be small in a well regulated exchange system, it is not always true that the construction and operating departments work cooperatively.

In cities where the trolley lines ramify in all directions, the chances are that the main and branch exchanges will lie in a direct line between the power-house and the terminal of a particular trolley line. This means that a difference of potential will exist between a ground connection at one office and a ground connection at the other. A relay connected by wire between these two grounds will be powerfully energized, and a receiver placed likewise will indicate the stopping, running and starting of cars, the hum of the station generators, the ticking of telegraph sounders and divers other noises. Such trouble the trunks shown in Figs. 7 and 8 had to experience. During connection, the ground of each battery was placed in connection, and the earth currents passed through both sides of the trunk circuit throughout their entire length. Whether the trunks were well transposed or enclosed in lead-covered cables the entire length, thereby entirely free from inductive troubles, the great conductive trouble remained, and the connection was invariably noisy. It became necessary to design a trunk circuit, which eliminated the flow of earth currents throughout its conductors.

If a current of sufficient strength passes through a relay, it will energize it and pull up its armature. If the battery and relay circuit is opened, current can no longer flow because an infinite resistance has been placed in the circuit. But most relays do not have to have an infinite resistance inserted to make them release their armatures. Ordinary resistances like 5,000 ohms, or 10,000 ohms placed in a circuit containing a twenty-volt battery and a relay, will cause the relay to release its armature. If one would take the relay CRR, shown in Fig. 7, and connect it with a twenty-volt battery and a resistance box, varying from 50 to 10,000 ohms, he would find that the insertion of 1,000 ohms would not allow the armature to be pulled up. But to make that relay armature fall back after it is pulled up is a different matter. If 1,000 ohms will not allow the armature to be pulled up, it will take much more than 1,000 ohms to make it release its armature when once pulled up. It will take nearly 5,000 ohms. To make certain, 10,000 ohms should be inserted. The trunk circuit shown in Fig. 9 was designed on this principle of varying resistance through operative and non-operative limits, without opening the circuit.

The circuit shown in Fig. 9 indicates a change in the character of the relay DR. Otherwise, the locking relay is the same as in Fig. 8, and the lamps are lighted in the same manner as in Fig. 7. The

trunk operates just as formerly, and from the operators' standpoint, they do not know the difference between the operation of circuits 8 and 9. B assigns the trunk to the A operator in question, and A inserts her plug. This causes the trunk circuit to conduct current through the 12,000-ohm winding of relay DR, from the A battery and through relay CCR, without pulling up its armature, as the current is too weak. But the current is not too weak to operate DR, as it is composed of a great number of turns, and no energy is wasted by exterior resistance. Pulling up its armature puts a shunt about the lamp DL, rendering it dark. When B sees the darkened lamp, she rings the party by throwing key RK, putting alternating current on the line through the subscriber's condenser and bell. Inserting the plug lights the ringing lamp RL, by placing it in series with the winding of the line cutoff relay.

When the party answers the battery current passes through the relay CR, energizing it and causing its contacts to put a shunt circuit about the 12,000-ohm winding, composed of the sixty-ohm winding of relay LR, and the twenty-ohm winding of DR. The 12,000 winding and the twenty-ohm winding are wound on the same core in same direction, so that the relay as a whole is not weakened by the eighty-ohm shunt. The relay CCR is not sensitive enough to operate through 12,000 ohms, but it will readily operate with that high resistance reduced to eighty ohms. Relay CCR will put a shunt about CCL, and A knows that the party has answered.

The increased current from A due to the decreased resistance is utilized by relay LR, which acts on its armature and closes a ten-ohm winding about lamp RL, darkening it and telling B to cease ringing on the line.

As in Fig. 7, all four lamps are dark upon talking connection. When the originating party hung up, the lamp ACL lighted. When the called party hangs up, relay CCR releases the shunt about CCL, and causes it to light. Relay CCR releases its armature, because it has not the power to hold it after cord relay CR has released its contacts. The opening of these contacts removes the sixty and twenty-ohm windings from their parallel position with the 12,000-ohm winding, thereby leaving the 12,000-ohm winding alone in the circuit. Relay CCR acts as if its circuit were opened, although it is still furnishing current to DR through its windings. Relay LR does not release contacts and lamp RL remains dark. A withdraws plug and DR is deenergized. Lamp DL lights and the disconnection is entirely completed by B.

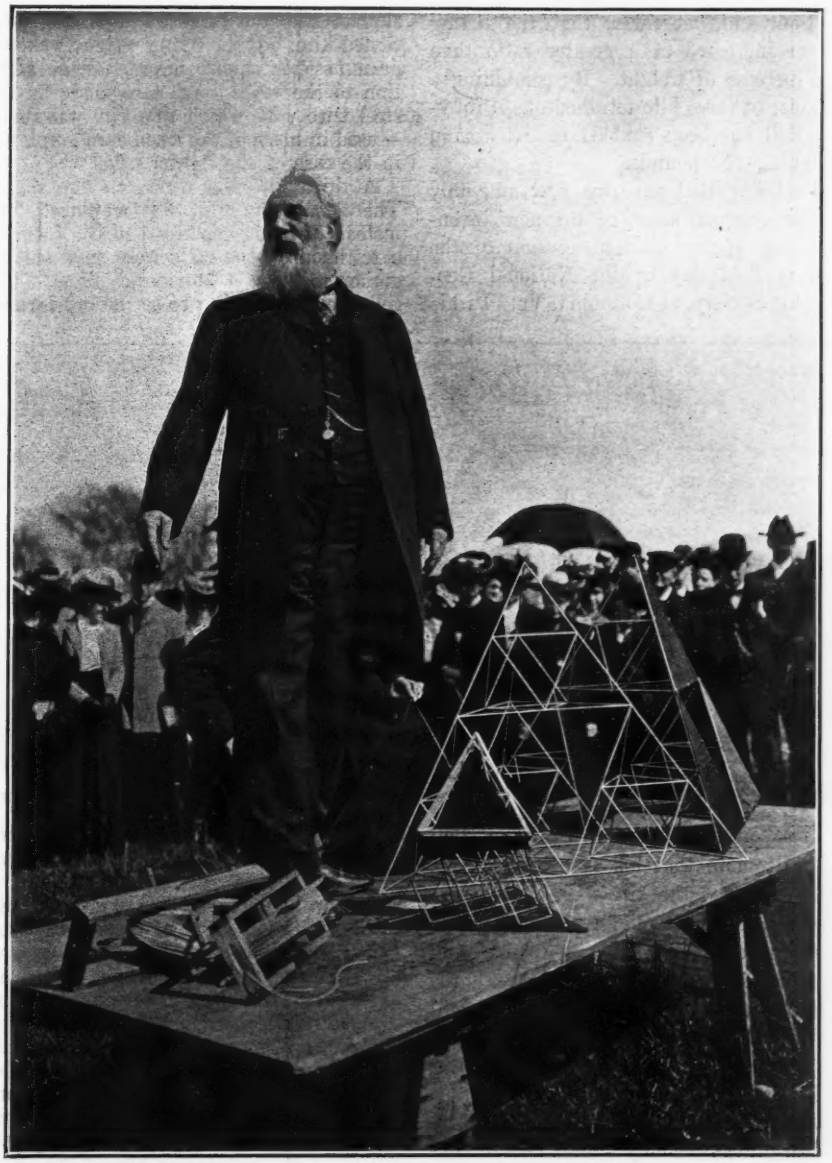
This trunk is a quiet one, and the only thing to mar its operation is an occasional transposition, which will cause the battery from A to oppose the battery from B in the relay LR, causing a strong buzzing sound on the connection, and forbidding the locking of LR.

PROFESSOR BELL AND HIS KITES.

BY WALDON FAWCETT.

Professor Alexander Graham Bell, inventor of the telephone, has been deeply absorbed during the past year or two in an effort to solve the problem of aerial navigation through the medium of kites. Professor Bell, unlike many inventors, reaped a rich monetary reward from the results of his first great invention and has thus been enabled to spare no expense in his present pursuit. His investigations and experiments have been conducted at Washington, D. C., and at his laboratory at Burdetts, Nova Scotia, where his summer home is located, but it is only within the past few weeks that he has consented to take the scientific world into his confidence regarding the results thus far attained.

All Professor Bell's work has involved the utilization of a kite structure. When he entered upon his investigation of the subject he found that all box kites and flying machines of this order were defective in two ways. In the first place the box kite is braced in a horizontal and vertical direction, but not otherwise, so that cross supports have to be introduced in the frame, which increases the weight without adding to the flying power, and at the same time operates as an obstacle to the wind. In the second place the box kite type of airship—of which Professor Langley's famous aeroplane is an elaboration—has a second serious defect in that the weight increases with the cube as



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PROFESSOR BELL DEMONSTRATING HIS KITES.

rapidly as the lifting power does with the square, so that the larger the kite the less it will lift in proportion.

In view of these discoveries, Professor Bell was led to construct a kite the frame of which presents the form of a triangle, no matter from what side it is viewed. In other words, the frame is a perfect tetrahedron and, in his experiments, the electrical inventor found, as he had anticipated, that it was self-braced in every direction, and, moreover, that the lifting power increased at a greater ratio than the increase of weight. By combining a number of these kite tetrahedrons, Professor Bell has been enabled to lift a man weighing 200 pounds.

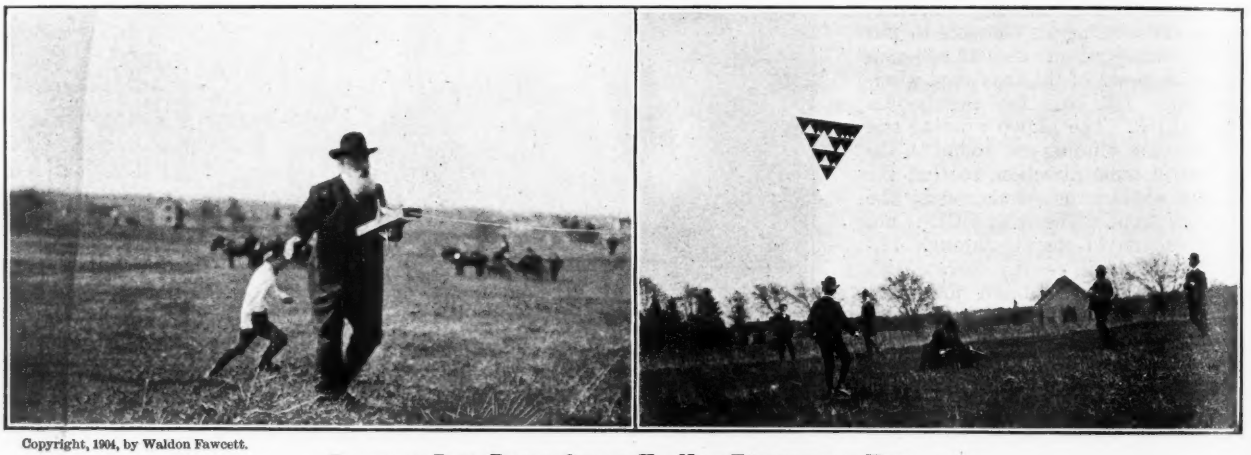
Professor Bell gave his first and only public demonstration of his new invention this spring on the occasion of the annual field day of the National Geographic Society, at Columbia, Va. In his address on that occasion Professor Bell made it plain that his experiments have not yet passed the kite stage, but he expressed the firm belief that when in the evolution of the modern airship the problem of overcoming gravity is solved, the tetrahedral principle of construction will be found to have advantages over the ordinary flat-surface aeroplanes in the matter of both weight and cost.

The inventor declared that the tetrahedral unit is the only known unit of construction which offers a corresponding increase of lifting power with increase of weight. A flat surface or plane gives but one-fourth increase in lifting power to the increase in weight, and is, moreover, inadequately braced, whereas in the tetrahedron no strain can come to one portion of the structure which the others will not receive by even distribution. Professor Bell's achievements have been attained by combining numbers of these kite tetrahedrons.

In connection with his address before the National Geographic Society, Professor Bell sent aloft several specimens of his kites. The first one introduced was a framework of wood covered with red silk, and weighed 1,291 grammes. It had a surface of 3,464 square metres and the flying weight was 373 grammes to the square metre. Another kite was of aluminum construction and weighed three pounds nine ounces or 1,617 grammes. The flying surface was the same as the first mentioned kite, but the flying weight was 467 grammes per square metre. Some addition to the weight was also made by the steel wire with which this kite was flown —used in place of the linen cord employed in the case of the lighter kite.

A third kite was of distinctive shape. The tetrahedral unit was employed, but instead of being combined in the form of a tetrahedron the cells were fastened together to form a horizontal plane. The cells were placed in two series and formed a kite about six feet long and fifteen inches wide. A convincing demonstration was given of the supporting ability of the tetrahedral principle. The aluminum kite frame, with its ribs of apparently the most fragile construction, was placed across two poles and a boy was placed on top of the structure. The weight of the boy had no effect whatever upon the frame and later a man weighing 160 pounds was permitted to swing on the frame by his hands. After this second and more severe test a careful examination was made, but failed to disclose the slightest change in the position of any of the units of the structure.

Professor Bell's work thus far, interesting and promising as it is, is largely preliminary in character. The really significant phases will probably be disclosed during the coming summer, for Professor Bell states that he has invented a motor which he will, within the next few months, test with his kites in order to if possible arrive at some definite conclusions as to his ability to construct a flying machine which will be completely under control on the principle of the tetrahedral kite.



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PROFESSOR BELL FLYING ONE OF HIS NEW TETRAHEDRAL KITES.

Massachusetts Institute of Technology.

The entrance examinations of the Massachusetts Institute of Technology, Boston, Mass., will be held in two sessions, one beginning in June, and the other the latter part of September. These examinations are held at a large number of points throughout this country and Europe. A circular describing the requirements for admission may be obtained by addressing the secretary, Mr. H. W. Tyler, 491 Boylston street, Boston, Mass.

The institute is offering summer courses in a number of subjects, those of particular interest to electrical engineers being mathematics, mechanical draughting, mechanical arts, modern languages, physics and mechanical drawing. These courses run during the months of June and July, and supplement the work of the regular year. The requirements for admission, work performed and the final examinations correspond to those of the regular school year. These courses are open to persons who are not students of the institute, if they possess the necessary qualifications.

Radium Minerals in Quebec.

Under date of March 25, 1904, United States Consul-General W. R. Holloway, of Halifax, Nova Scotia, transmits the following from the Halifax *Mercantile Maritime Merchant and Commercial Review:*

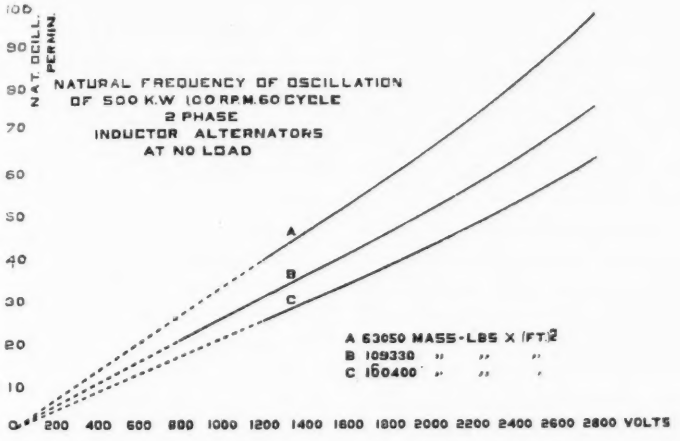
"Mineral containing radium have been discovered in the province of Quebec. The ore from which radium and oxide of uranium have been extracted was taken from a white-mica mine about eighteen miles back of Murray Bay, in Charlevoix County. White-mica deposits exist at several points in Quebec and eastern Ontario, and these will be developed next summer by an electric company, which hitherto has imported its mica supplies from India."

NOTES ON FLYWHEELS.[1]

BY H. H. BARNES, JR.

The choice of a flywheel for reciprocating engines direct-connected to alternators is a somewhat serious matter in view of synchronous operation. With prime movers giving a uniform torque, and for belted units, a flywheel for the general purpose of obtaining a proper mechanical balance for the operation of the engine is all that is required, and the fact that an alternator has to be driven does not enter into the problem. With direct-connected reciprocating engines, however, it is customary to specify a flywheel that will limit the angular displacement from the mean position under the worst conditions to a given number of degrees, the limit usually being set at ± 2.5 electrical degrees. This rule, it has been claimed, gives the best all-round results for the operation of alternating-current machinery. In the following pages an outline has been given of comparative tests of alternators with both light and heavy flywheels, the results of which go to show that a good word may also be said for somewhat lighter wheels than the ones to which the above rule leads.

Any one who has watched the generator instruments in a plant operating alternators in multiple will have noticed a slight periodic swing of the pointers. A closer study of these beats shows there are two distinct varieties. Usually the swing is in step with the revolutions of the engine and is entirely independent of the field excitation of the alternator. In other cases the beats have a distinct period of their own that varies with the field excitation and consequently with the bus-bar pressure. In the first case the variation in the driving torque of the engine, which repeats itself periodically with each revolution, imposes itself upon the alternators and gives forced oscillations. The variable period, on the other hand, is that of natural oscillation. Natural oscillations invariably appear when an alternator is paralleled a little out of step, and under some other conditions as well, and occasionally even predominate to the exclusion of forced oscillations. At all events, it is an easy matter to determine the natural period experimentally. Its importance and its intimate relation to flywheel capacity will be more thoroughly appreciated if we analyze the results obtained in three different plants in which alternators of identical design are direct-connected to cross-compound reciprocating engines. The interesting feature in these plants and the reason for singling them out being that, while the generators are identical and the engines nearly so, the flywheels differ very considerably in weight.


NAT. OSCILL. PER MIN.
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2 PHASE
INDUCTOR ALTERNATORS
AT NO LOAD
A
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C
A 63050 MASS-LBS X (FT.)2
B 109330 " " "
C 160400 " " "
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 VOLTS

NATURAL FREQUENCIES OBTAINED EXPERIMENTALLY FOR EACH PLANT AT NO LOAD.

The generators throughout are 500-kilowatt, two-phase, 100 revolutions per minute, sixty-cycle units of the inductor type. Their short-circuit ratio with no-load excitation is 3.5.

The following table gives the flywheel data:

Plant.	Flywheel.		Moment of Inertia in Lbs. × (Ft.)²		
	Weight of Rim in Lbs.	Outside Diameter in Feet.	Flywheel.	Revolving Element of Alternator.	Total.
A	30,000	15	46,150	16,900	63,050
B	50,000	16	92,430	16,900	109,330
C	60,000	18	143,500	16,900	160,400

The natural frequencies obtained experimentally for each plant at no load are shown in Fig. 1.

It will be noted that the units with the lighter wheels have the higher natural frequency, as was to be expected. The effect of this difference in natural frequency upon the behavior of the engine governors is marked. With the governor dash-pots in the condition in which the engine builders left them, parallel operation at normal pressure was a failure in all three plants. Upon throwing two units together, cross-currents would build up, and eventually the surging would become so violent that the machines would have to be separated. The frequency of surging was that of natural oscillation throughout. With the same setting of the engine dash-pots, however, the machines in C would run together acceptably at no load at pressures of sixty per cent and less of normal, and the machines in B at pressures of forty per cent and less of normal, whereas those in A failed to operate satisfactorily at fifty per cent of normal, which was the lowest pressure tried.

By artificially decreasing the oscillations of the governors, by means of the dash-pots, the units in A could be made to operate well at normal and higher pressures. The units in B showed an improvement at pressure considerably above normal (tests at reduced pressures had to be omitted here to avoid interfering with the commercial operation of the plant), while no improvement whatever was noticeable in C, except for the lower pressures. The former average limit of sixty per cent of normal being extended to over eighty per cent.

A still further increase in the damping of the governors in C, however, resulted in a decrease in the limiting pressure, until with completely blocked governors parallel operation became impossible at any and all pressures. This result and similar ones obtained elsewhere would indicate, it seems, the existence of an inherent tendency toward cumulative surging that is in no way connected with the behavior of the engine governors.

The origin and nature of this tendency are not directly apparent. It seems likely that they are intimately connected with the armature reaction of the alternators, but whether a departure from a uniform turning moment in the prime mover is also essential to its appearance may be doubted. As far as the writer is aware,

[1] A paper presented at the 177th meeting of the American Institute of Electrical Engineers, New York, May 17-18, 1904.

there is no indication in dynamics in the theory of forced and natural oscillations of a possibility of forced oscillations producing cumulative surging. If this is so, it might be imagined, although there is no direct experimental evidence to support the idea, that the surging which so frequently appears and is at times so hard to control, in alternators operating in multiple (to limit ourselves to a definite case) is due, not to the lack of uniformity in the turning moment, but rather to the effect of heavy wheels upon armature reaction phenomena. It is also probable that we have operating, in addition to this, causes of the same nature as those that produce cumulative surging in a Watt governor system. It should be clearly understood that this is hardly more than a guess. But it is one that would be worth while checking up by making the following test, for which the writer has unfortunately not had an opportunity.

In a plant in which direct-connected alternators are given to chronic cumulative surging that will not disappear even when running on the throttle with governors blocked, disconnect the engines and drive the alternators by means of individual constant-current motors. If we parallel the alternators under these conditions and surging still persists, we will have eliminated from the problem the angular variation of the engine. If it should fail to appear, however, the origin of the trouble would be definitely located in the engine. Whatever the origin of this inherent tendency to surge may be we must more than counteract its effect to ensure successful parallel running, a result that may be brought about in two ways: by using heavy wheels—or else by operating at reduced pressures—the natural period of the unit may be lengthened to such an extent that the engine governor, instead of adding to the disturbance will have time to grapple with any surging that may appear, and wipe it out. An example of this is the behavior of the machines in plants B and C at reduced pressures. This solution has the drawback of leading to wheels of prohibitive weight for slow-speed units, and, furthermore, of making the successful operation of the plant dependent to a certain extent upon the adjustment of the engine governors.

The second and better way to overcome the inherent tendency to surge is to provide sufficient electrical damping. Any oscillations that may appear will then be taken care of by the damping, and the assistance of the governor will no longer be required. In fact the damping action will be more rapid and final if the governor dash-pot is adjusted so that the governor will not respond to natural oscillations, as, in the majority of cases, it would only strive to maintain the latter if left free to act. As it is easier to adjust, the dash-pot with this end in view, to bridge over a short period than a long one, we see that light wheels with their short periods are more desirable in this respect than heavy ones. This argument may seem weak at first when applied to plants in which forced oscillations predominate, but experience teaches that the disturbing influence of the natural period is felt, even when there is no immediate indication of its existence on any of the switchboard instruments. More delicate instruments than the ones usually used would probably reveal the natural period, and even with instruments which appear at first to indicate forced oscillations only, a battle for supremacy between the forced and natural periods may frequently be detected by scrutinizing the movements of the pointers with more than usual care.

To bring out a little more clearly the effect of a change in weight of wheel upon the behavior of the engine governor, we might say that with very heavy wheels and consequently long natural periods the governor is able to kill off unaided any surging that may attempt to develop. With very light wheels, on the other hand, the governor is barely affected by surging and the task of holding it down devolves upon the electrical damping of the units. There is an intermediate zone between these two extremes in which the governor would directly assist the tendency to surge if it were not prevented from doing so by special adjustment of its dash-pot. If such adjustment is not made, it is evident that what electrical damping there is will be more sorely taxed, and the heavier the wheel the more likely it will be that the damping will be unequal to the task of carrying this additional burden and that cumulative surging will set in.

If neither of the conditions we have been discussing is met, as in plants B and C at normal voltage, successful running may be said to be out of the question. The best remedy for the cumulative surging that will undoubtedly set in in such cases is to increase the electrical damping of the machines, until it is able to hold in check the inherent tendency to surge. This was done in the above plants with eminently satisfactory results.

It may also be pointed out that the successful running at normal pressure with dampened governors in plant A, compared with the failure to run in plants B and C, would indicate that the relative increase in electrical damping is more rapid than the corresponding increase in the inherent tendency to surge for a given decrease in weight of flywheel. Should this be corroborated by similar observations elsewhere, a further most weighty argument would be added in favor of light wheels. However this may be, the tests already described, and they are but a few of those that could be cited, lead to the conclusion that a decrease in flywheel capacity is not synonymous with an increased tendency to surge on the part of alternators. The following observations will emphasize this point still further.

In plants A and B individual exciters are belt-driven from the shaft of each alternator, and facilities for paralleling the exciters are provided, besides the usual switches. With this arrangement, if two alternators are paralleled while energized by their own separate exciters, and the pressure and dash-pot conditions are such that cumulative surging sets in, the surging may be very rapidly stopped at all loads by simply paralleling the exciters. Tests were made to ascertain the nature of this action of the exciters. The results proved that it is directly comparable to that of electrical or viscous damping and not related to the constancy of the exciter pressure.

Other conditions being the same, it is reasonable to assume that the time taken to dampen out cross-currents by paralleling the exciters would give a fair indication of the relative tendency to surge existing in these two plants. Actually, the average time required is about the same in both plants, with possibly a slightly quicker action in A. From which the conclusion must again be drawn that a decrease in flywheel capacity and consequent increase in angular variation while running does not decrease the stability of the generators. In making these tests it was noticed that individual results in A were affected to a very slight extent by the relative position of the driving cranks of the engines. In B and C and numerous other plants experimented upon, this influence, if it existed at all, was so slight that it was impossible to distinguish it from that due to other causes.

Passing on to another phase of the subject, we find that the limitation usually imposed upon the maximum angular variation of alternators is intended, among other things, to limit the cross-currents due to this variation. Thus, for a variation of $\pm$ 2.5 electrical degrees and a short-circuit ratio of 2.5, the cross-current will amount to approximately ten per cent of the full-load armature current, and no

more. If we consider, however, that a ten per cent current results in an I^2R loss of less than one per cent of normal, and that that normal I^2R armature loss is itself but a fraction of the total loss in the generator, we realize that at least a twenty-five per cent cross-current may be permitted without fear of appreciably increasing the total losses. Especially as such cross-currents would appear under the most unfavorable conditions of load and cut-off only, the average exchange of current during the day's run undoubtedly remaining well below the maximum. It might be well to add that there should be not any trouble from blinking of the lights if the cross-currents do not exceed the value mentioned. There do not appear to be any very good reasons, therefore, why objections should be raised on this score to the use of lighter flywheels giving a considerably great variation than the customary 2.5 degrees.

We shall now examine the effect of a light wheel on the generating units upon the behavior of synchronous apparatus. We have in C a good example of a plant working under these conditions. Exceptionally light wheels are in use there and numerous synchronous motors and rotaries are in operation on the system. Not a trace of trouble has developed in this plant since the start, however, notwithstanding the light wheels.

Some interesting experiments that are very much to the point were made recently by Mr. P. C. Oscanyan. In a plant equipped with 850-kilowatt, sixty-cycle, ninety revolutions per minute alternators, direct-connected to cross-compound reciprocating engines, the flywheels were designed to maintain the angular variation within ± 2 degrees of mean. The rims of the wheels were laminated and weighed normally 80,000 pounds. With a machine with but one-quarter of its rim in place running singly and in parallel with a completed unit, no difference whatever could be detected between the behavior of the incomplete machine and that of its neighbors. It would operate in parallel under all conditions of load, and when running singly would carry a load of synchronous converters without any indication of trouble. On the strength of this, and without going further, it may be said that surging and allied troubles in synchronous apparatus are not necessarily associated with light wheels and increased angular displacement. They are due, it would appear, more to certain imperfectly understood relations between the number of generating and receiving units, their moments of inertia, output, speed, etc., than to the existence of a more or less pronounced angular variation dependent upon the flywheels.

The question of electromechanical resonance remains as being about the only possible further source of trouble that might be introduced by a change in weight of wheel. Resonance, it may be added by way of explanation, is said to exist in a system when the ratio of forced and natural frequencies is nearly or exactly equal to unity; its effect is a tremendous amplification of the original forced oscillation.

By referring to the curves of natural frequencies, we see that the normal natural frequency of the units in plant A is eighty-one per minute. The forced frequency determined by the revolutions is 100. By forcing the excitation until we reach pressures and consequently natural frequencies, that are considerably above normal, we might expect to see the effects of approaching resonance. In reality, noticeable cross-currents begin to appear at a frequency of eighty-seven; at ninety they are already quite pronounced. They are not cumulative, however (provided the engine dash-pots are in order), but increase and decrease periodically with a main frequency equal to the difference between the forced and natural frequencies. The slip, as it were, between the two frequencies may be counted in this way with great precision. We have here the phenomenon of interference, which appears whenever the damping of a system is very weak. If we increase the damping in this case, as, for instance, by paralleling the exciters, the main period disappears, and the cross-current take on an average value with a regular but slight beat of forced frequency. A further increase in natural frequency runs up the cross-currents very rapidly until they are far in excess of the full-load armature current for a ratio of frequencies nearly equal to unity. These results show clearly enough that resonance is a real and very serious danger, and one to be avoided with the utmost care, as there is no acceptable way of overcoming it when encountered in practice. In order to avoid it, we should have a formula for predetermining the flywheel and the corresponding natural period, which we could then make as different as we choose from the forced period, already determined by the revolutions of the engine.

The oldest and at the same time the best formula for this purpose that the writer knows of was published by Paul Boucherot in 1892, in vol. xlv, issues Nos. 31 and 32 of *La Lumiere Electrique*. It is, with a recent slight modification:

$$T = 0.31\ N \sqrt{\frac{M}{f \times E \times I_e \times p}}$$

where

T = natural period of oscillation in seconds at no load.
N = revolutions per minute.
M = Total moment of inertia of all rotating parts (flywheel, crank discs, inductor or revolving field, etc.), expressed in lb. × (ft.)².
f = electrical frequency per second.
E = effective electromotive force per phase or leg.
I_e = effective short-circuit armature current corresponding to E.
p = number of phases.

The greatest discrepancy that has thus far appeared in checking this formula experimentally in nearly a dozen plants is one of + six per cent the calculated period being much longer than the observed one. The mean error for all the plants was + three per cent. The reliability of the formula for practical purposes is therefore beyond doubt.

With this formula to assist us, it is an easy matter to predetermine a flywheel that will at least avoid resonance once we have agreed upon the closest ratio permissible between the forced and natural frequencies. The choice of this ratio depends upon numerous considerations. In the first place we have, as the essence of resonance, the increase in angular variation that is bound to appear after paralleling, even when absolute resonance is still quite remote. There is also the possible error between the calculated and the actual flywheel, the rather doubtful values that are sometimes used for the short-circuit current and the increase in natural frequency with the load and with a decreasing power-factor. Making due allowance for these various factors, let us assume for the moment a natural frequency at no load equal to seventy per cent of the forced.

If we introduce this condition into the preceding formula and substitute $P \times k$ for $E \times I_e \times p$, and $W r^2$ for M wherein P is the normal output of the alternator in kilowatts, k the ratio between the short-circuit and full-load armature current, W the weight in pounds and r the radius of gyration in feet of all the revolving parts combined, we get

$$W r^2 = 25 \frac{P \times f \times k}{\left(\frac{N}{100}\right)^4}$$

It remains to be seen if a wheel based on this formula is sufficiently heavy to keep the cross-currents within bounds. It appears upon examination that for such a

wheel the maximum cross-current between alternators driven by any average cross-compound steam engine would not exceed twenty-five per cent of the full-load armature current, even under the worst conditions, which may be considered an entirely permissible figure.

For an ordinary cross-compound unit and a short-circuit ratio of $k = 2.5$, the maximum angular variation may be assumed to be within ± three electrical degrees of mean when running singly. With a seventy per cent ratio of frequencies, however, the angular variation of a unit running singly will be practically doubled upon paralleling it in with its fellows, and it is upon this increased variation that the calculation of the cross-currents has been based. With alternators with a higher short-circuit ratio and therefore better regulation, the angular variation will be less on account of the heavier flywheel called for by the formula. The cross-currents, on the other hand, remain the same for a given type of engine regardless of the regulation of the alternators. With single-crank engines these currents will be somewhat heavier than with cross-compound engines, and with multi-cylinder engines a trifle less. The difference in the latter case will hardly be sufficient to demand a separate formula, and the same may be said of vertical as compared with horizontal types of engines. With single-crank engines, however, the maximum angular variation should be determined, and if the design of the engine is such that the variation in a single engine materially exceeds ± three electrical degrees, it would be advisable to modify the constant in the formula to a slight extent.

While there are apparently no disadvantages connected with the use of relatively light wheels, there are, at least, two distinct advantages that should not be overlooked. We have already seen that a light wheel means a high natural frequency for which it is relatively easy to get the engine governors to behave properly. In practice this is a very real and important advantage, and one not to be lightly dismissed.

A considerable saving in first cost may also be effected by using lighter wheels, especially in the case of slow-speed units, where the amount of iron that may be saved in the flywheel foots up to quite a respectable sum. At the same time the general wear and tear upon the bearings of the engines are lessened.

We believe, therefore, that the formula given above may be used with perfect safety in predetermining flywheels for direct-connected steam engine drive, with the following exceptions. For high speeds the wheels obtained, while meeting all electrical requirements, would hardly be heavy enough to give the engine a proper mechanical balance, and in such cases heavier wheels, as determined by the engine builders, should be used. Variations of the formula will also suggest themselves in individual cases. Thus, for instance, with engines giving an exceptionally even driving torque connected to alternators of excellent regulation, the permissible ratio between natural and forced frequencies might be advanced to 0.75 or even more without serious risk of encountering resonance phenomena or of introducing troubles of other origin. With single-crank engines, on the contrary, it will occasionally be necessary to use a somewhat heavier wheel than the one indicated by the formula.

To sum up our main conclusions, we may say that the flywheel—as distinct from the assistance given either by the engine governor or the damping of the unit—is impotent to ensure satisfactory synchronous operation. Except for these two influences, the inherent tendency toward cumulative surging existing in the unit would predominate, and parallel running would be impossible.

It also seems advisable to use a somewhat lighter flywheel than would be considered conservative practice to-day. This greatly facilitates the adjustment of the engine governors while it does not decrease the stability of the system. For it would appear that the electrical damping of the units (which varies with their natural period and consequently with the flywheel) at least retains its relative strength as compared with the inherent tendency to surge for wide variations in weight of wheel. Therefore, if the damping is sufficient to hold the tendency to surge in check when a heavy wheel is used, it remains so for a light wheel. This argument applies to a change in weight of wheel for a given generating unit only, and should not be construed as one in favor of increased angular variation as such.

We also find that electrochemical resonance is a serious danger that must be avoided by making a proper choice of flywheel. A wheel selected with this end in view is at the same time satisfactory for general operating purposes, provided there is sufficient damping in the unit to check the inherent tendency to surge.

If we enquire, in concluding, what flywheel capacity suggests itself for direct-connection to gas engines, it must be said that it would be a little venturesome to advance a cut and dried rule at present in view of the limited practical experience with this type of prime mover. By analogy with steam-engine experience, however, it may be said that light flywheels and vigorous electrical damping is the combination that is most likely to win out for this class of work.

FUEL ECONOMY FROM THE CHEMICAL POINT OF VIEW.[1]

BY JOHN B. C. KERSHAW.

The past attitude of the average works engineer toward the subject of fuel economy has been less progressive than in other directions. It is doubtful if he has even yet awakened to a realization of the fact, that there is much greater scope for economy in the boiler house than in the dynamo or engine rooms.

It is possibly true that engineers have not been more backward than other fuel users in recognizing the need for a scientific study of the question of fuel economy, and for the use of scientific, rather than rule-of-thumb, methods in the control of the combustion process. The author, therefore, is not disposed to blame them specially for their attitude in this matter. It is simply an expression of the general neglect of science by manufacturers in the United Kingdom, that is now admitted by most thinking men, and that is certainly one of the many causes which have led to our present somewhat unsatisfactory position as a manufacturing country.

For the purpose of the paper he will divide his subjects into three sections, and will deal, first, with the supplies of fuel and water; second, with the combustion of the fuel in the boiler furnace; and third, with the waste gases from the combustion process. Under each of these headings he will point out the defects of the present methods of examination and control, and will make suggestions which he considers would lead to great economies in actual practice.

I—FUEL SUPPLY.

The chemist, when he regards the conditions under which the engineer in charge of a large generating plant arranges his contracts for thousands of tons of fuel to be delivered over a period of some months, is struck by the absence of any effective means for checking the quality of the deliveries of the selected fuel. Fuel appears to be the only raw material the sale of which is conducted by what may fairly be called rule-of-thumb methods in place of scientifically exact tests.

Steam-raising trials are of course made, with sample wagons of various fuels, before the contract is signed, and the selection is based upon the results obtained in these trials. Here at the very basis of the system of selection there is a wide scope for uncertainty and error. The comparative wetness or dryness of the fuel

[1] Abstract of a paper read before the Liverpool Engineering Society.

as it is discharged into the boiler-house—a physical condition which must vary enormously in such a climate as ours, with coal carried long distances in open wagons; the humidity and coldness of the atmosphere, and the direction of the wind (all causes which influences the pull of the chimney); the state of the boilers as regard scale; and finally—but not the least—the skill and reliability of the fireman; are all factors which have great influence upon the results obtained in these "practical" steam-raising trials. The "reliability" of the fireman is perhaps the most important, though many engineers do not recognize this. Even where mechanical stokers are employed, the fireman in charge has much influence over the results obtained. The author recommends—not that such practical trials should be dispensed with, but that a thoroughly reliable sample of the fuel used for each steam-raising test should be submitted to chemical and calorific examination; and that the results obtained in the trials under the boilers should be judged in the light of these laboratory results.

The author recommends for practical purposes the "approximate" rather than the "elementary" analysis of fuels. The former gives the per cent of moisture, coke, volatile matters, fixed carbon and ash. The latter yields the percentage of the various elements, which are contained in the fuel—*viz.*, oxygen, hydrogen, nitrogen and carbon. For the guidance of the boiler engineer it is much more useful to know that a fuel contains (say) twenty-nine per cent of volatile hydrocarbons, thirteen per cent ash and fifty eight per cent fixed carbon, than to be informed that it contains seventy-two per cent C, 4.8 per cent H, 7.2 per cent O and 0.71 per cent N. Recently a formula has been published which permits the calorific value to be calculated from the results obtained by this "approximate" analysis; and therefore one of the arguments for carrying out the troublesome and expensive elementary analysis of fuel, *viz.*, that it enabled one to calculate with accuracy its calorific value, has lost weight.

A further advantage of having the exact figures of the laboratory trials of the fuel for reference, is that a check upon the deliveries of fuel during the time for which the contract is running can be easily kept. At weekly, fortnightly or monthly intervals reliable samples of the fuel should be taken and submitted to the approximate analysis and laboratory calorimetric tests. Any variation in the quality of the fuel should at once be reported; and the fact that such examination of their deliveries at the boilers was being periodically made would have undoubted effect upon the firm fulfilling the fuel contract and upon the colliery managers.

It may be urged that periodic steam-raising trials are sufficient. Apart from the unreliability already referred to of the results obtained in such trials as guides to the quality of the fuel actually being delivered, there is the question of trouble and expense involved in conducting them. On the ground of expense alone, the laboratory examination of carefully taken samples is to be preferred.

The chemical examination of fuel is regularly carried out in the laboratories of the railway companies, and of the large chemical and metallurgical works in this country. The author knows that the managers of these works would not readily be deprived of this check upon the deliveries of one of their most important and costly raw materials. The engineers of electric light and power stations, or of engineering works generally, would be wise to follow the same plan, and if their consumption is not large enough to warrant the engagement of an analytical chemist and the equipment of a laboratory for this work, they might with advantage send their samples of fuel to one of the numerous chemists who specialize in this class of work. The analysis of fuel and the determination of its calorific value is not work of a very simple character, and the author does not recommend engineers to attempt it themselves. Even in the matter of sampling, much care and attention are required if the sample is to be a thoroughly representative one, and the weight of fuel to be sampled is large. The idea of many engineers, that a shovelful of fuel selected haphazard and placed in a box is a sample is somewhat childish in its conception. For the guidance of engineers in this matter, a set of rules to be followed in sampling fuel is given in the appendix to this paper.

II—WATER SUPPLY.

Most engineers are now ready to recognize the value of analysis in connection with the supply of water for boiler purposes, and are prepared to admit the heat losses due to scale formation inside their boilers. Where the hardness of the water used for feeding the boilers is above fifteen English degrees, equivalent, that is, to fifteen grains of calcium carbonate per gallon of water, some form of water-softening apparatus ought certainly to be adopted. It is indeed questionable whether such an installation would not also prove remunerative in large power stations, when the water employed is above this standard of purity. The author is in favor of external treatment of the water before entering the boiler, and does not approve the use of "boiler compositions." So far as his observation goes, the more up-to-date electricity generating stations in this country are well equipped with apparatus for this purpose, and many of the engineers of the remaining generating plants would agree that water-softening is an essential condition of fuel economy for both large and small power stations.

Lime and carbonate of soda, or caustic soda, are the usual chemicals used for water-softening. The amount of these which it is necessary to employ can only be determined by chemical examination of the feed water. It is customary to base this calculation upon the results of one analysis only; but the examination should be repeated at quarterly or shorter intervals, for the character of the water supply may change, and the appearance of a water is no guide to its chemical constituents. Calcium carbonate and sulphate, and the corresponding magnesium salts, are all held in solution in water, and may increase greatly in amount without any change in the water becoming visible to the eye. Water drawn from brooks or rivers in the vicinity of the coast may also, at the times of flood or spring-tide, become contaminated with much sodium chloride, and this is another salt which should not be permitted to collect in any large amount inside the boilers, since it leads to pitting and corrosion of the plates.

Here again no change in the water can be detected by the eye; and chemical analysis will alone reveal the presence of this impurity in excessive amount. Periodic examination of the water used in the boilers by an expert chemist is therefore essential as an aid to economical steam production; and for most waters used for boiler supply, treatment with softening chemicals will, as the result of this chemical examination, be found necessary.

III—THE COMBUSTION OF THE FUEL IN THE BOILER FURNACE.

Coal may, for practical purposes, be regarded as a mixture of solid carbon and volatile hydrocarbons, with moisture and ash as impurities. Engineers have not sufficiently recognized the combustion difficulties due to the high percentage of volatile matters present in many fuels, and to the need for large combustion chambers to obtain perfect combustion in such cases.

The perfect combustion of bituminous coal demands conditions which are not

often met with in the modern boiler plant. These conditions are.

1. A sufficiency of air; but not an excess of the same.

2. A sufficiently high temperature in the combustion chamber.

3. A perfect admixture of the air and volatile hydrocarbons.

The first and second of these conditions are not always fulfilled in the ordinary working of boilers. Condition three is seldom recognized as essential; and where it is attained, it is more the result of chance than of design.

The supply of air to the boiler furnace is, of course, controlled by the fireman; and the tendency where no chemical examination of the flue gases is made is—in large towns especially—to work boiler fires with a large excess, since it is more easy to get over the smoke difficulty in this way. With the exit gases at a temperature of 600 degrees Fahrenheit, the losses due to excess air may vary from thirteen per cent to sixty-eight per cent of the fuel burned. The latter loss is that represented by only three per cent of CO_2 in the waste gases, and is of course exceptional. But the author has many times found only seven per cent to eight per cent CO_2 in the waste gases from modern boiler plants; and this shows a fuel loss of twenty-five per cent—or double that which would be incurred, with more careful attention to this question on the part of engineer and fireman.

With boiler plants burning fifty tons of coal per day, a saving of $3,300 per year might be expected by careful supervision of this one point alone.

To sum up the position as regards excessive air supply:

With careful firing and correct draught an average of fourteen per cent of carbonic acid should be present in the chimney gases. The ordinary percentage is far below this figure, and some authorities place the general average at only eight per cent. This low percentage is due to excessive draught, and consequent unnecessary amount of air passing through the boiler flues. The result is a large increase in the amount of heat carried away by the waste gases. The actual loss—represented by the difference between fourteen per cent and eight per cent CO_2 in the waste gases with chimney gases at 560 degrees Fahrenheit—is equal to ten per cent of the fuel burned in the boilers.

As regards the question of working boiler furnaces with too little air, and thus producing CO in place of CO_2 with consequent loss of heating effect, this danger is minimized by the fact that with the cheaper forms of fuel, smoke is always produced under such conditions; and the fireman has thus a visible check upon his action in this matter.

A new instrument for registering the draught—in the furnace and before the damper, called the pyrimeter—has just been placed on the market; and it is possible that the use of this by boiler engineers would also conduce to more efficient regulation of the air supply to the boiler fires.

As regards the second condition of perfect combustion, *viz.*, the maintenance of a sufficiently high temperature in the combustion chamber, this is a condition absolutely essential in the burning of fuels containing ten per cent or over of volatile hydrocarbons; and it can only be ignored when using coke or anthracite fuels. Unfortunately, boiler engineers have not generally recognized this condition in the construction of setting of modern boilers, and nine-tenths of the factory smoke produced in this country may be ascribed to the failure to maintain this condition within the boiler furnaces. The water-tube boiler makers are the chief offenders in this respect; and in most of their boilers, as at present constructed and set, perfect combustion of the fuel can only be obtained when employing the high priced anthracite or South Wales steam fuels. When ordinary bituminous fuels are used in such boilers, the volatile hydrocarbons which distill from the grate, even when mixed with a sufficiency of air, are brought too quickly into contact with the boiler tubes, and the temperature of the gases is thus greatly reduced before perfect combustion has had time to take place. The obvious method of obtaining the combustion temperature is to provide a combustion chamber, lined with some refractory and non-conducting material, which will not allow heat to be dissipated before perfect combustion of the gases has occurred.

In connection with this branch of the subject, it may be pointed out that the evaporative efficiency of a boiler is increased by obtaining the highest possible initial temperature in the combustion process. According to Stromeyer, the heat transmission between the water and the hot gases is directly proportional to their difference in temperature, and therefore the heat transmission is higher the greater this difference. Boiler engineers have as yet made no serious attempt to increase the temperature of the combustion process by heating the air used in the boiler furnace.

When one sees the remarkable results and high thermal efficiencies obtained with the regenerative principle applied to glass furnaces, one is tempted to ask whether some of the heat permitted to escape with the waste gases from boiler plants could not be utilized in this way; and the author is of opinion that this subject is well worth the attention of boiler engineers. Double-walled flues and a chimney with an inner steel air-shaft might solve the problem, but in this case forced draught would be necessary.

Turning now to a consideration of the third condition for perfect combustion, *viz.*, perfect admixture of the air and volatile hydrocarbons—here again we find the condition is imperfectly provided for in the ordinary boiler furnace when burning bituminous fuels.

It is evident that the mere opening by the fireman of the slide in the furnace doors will neither provide the amount of air nor the admixture requisite for burning the great volume of volatile hydrocarbons given off immediately after charging fresh fuel. A supply of air, preferably heated, coming in behind the bridge or at the rear of the firegate, is necessary in order to obtain perfect combustion, and this air must be distributed over the width of the furnace, in order to provide all portions of the mass of volatile hydrocarbons with the oxygen necessary for their conversion into carbonic acid gas and aqueous vapor. A secondary combustion chamber, walled with non-conducting material, is also necessary, in order to guard against loss of temperature before the combustion of these volatile gases is completed. The neglect of boiler engineers to provide for the combustion of these volatile hydrocarbons, save in the case of one or two special types of boilers, has led to the invention of a number of patented smoke-prevention appliances (some good and some bad), which would have been utterly uncalled for had a little more knowledge of chemical science been included in their educational curriculum.

IV—THE WASTE GASES.

From what has already been said under heading III, it will be gathered that the regular and systematic examination of the waste gases passing from boiler plants is absolutely necessary for the attainment of the highest possible efficiency with the fuel used. Such examination should include the temperature of the exit gases—the draught behind the dampers—and the chemical constituents of the gases.

The chemical constitution of the exit flue gases may be ascertained with various forms of apparatus, but none of these, it may be remarked, will yield valuable re-

sults, unless considerable thought, care and attention have been given to the sampling of the gases. A sampling hole for drawing samples ought to be left at the time of setting in the top or side flue-walls of each boiler, at that point where the boiler exit flue joins the main flue to the chimney. A reliable average sample of the flue gases passing a given point in two or three hours is, however, exceedingly difficult to obtain, and the author recommends in preference a series of snap tests at short intervals of time. The average of these results gives a far more reliable check upon the work of the boiler and fireman. The complete examination of flue gases for CO_2, CO and O is most conveniently carried out in the Orsat-Lunge form of gas-testing apparatus.

V—CONCLUSIONS.

The author in this paper has attempted to prove that there is considerable scope for economy in the working of most boiler plants, and that more attention to the chemical side of the question on the part of engineers would materially reduce their annual expenditure upon fuel. In the most interesting address delivered by our president a fortnight ago, some figures were given showing that the works costs per Board of Trade unit of electricity, generated in some of the best managed stations in this country, varied from 0.52d. to 0.70d. (1.04 to 1.40 cents); the average for six stations referred to being 0.62d. (1.24 cents). The fuel costs per unit for the same six stations varied from 0.19d. (0.38 cent) at Glasgow to 0.41d. (0.82 cent) at Bootle; and the average for the six stations is 0.29d. (0.58 cent) per unit. Fuel, therefore, in some of the best managed and most up-to-date electricity supply stations in Great Britain is accountable for nearly one-half the total works costs (forty-six per cent); and any proposals for reducing this item of expenditure should receive the most careful consideration from electrical engineers. The total expenditure upon fuel per year in these six electrical supply stations, calculating from the aggregate output given by Mr. Miller (36,975,000 Board of Trade units), must have been nearly £38,500 ($192,500), and if the author's assumption be correct that twenty per cent of this fuel might be saved by greater attention to the chemistry of fuel combustion, the annual saving in £ s. d. would be represented by nearly £8,000 ($40,000).

The steam-raising trials made with mechanical stokers also serve to indicate that the fuel efficiencies obtained in most boiler plants, working under normal conditions, are much below the maximum possible. The author is aware that the results obtained in these trials are looked upon with suspicion by many engineers. But, although it is improbable that these high efficiencies could be regularly maintained under actual working conditions, they are useful as showing what can be achieved when scientific supervision of the boilers is carried on from hour to hour, and when chemical tests of the flue gases are used as a check upon the work of the firemen. The high evaporative efficiencies obtained in such trials are, in the author's opinion, due rather to these conditions than to the fact that a mechanical stoker has been substituted for the human machine. An intelligent fireman is equal to, if not better than, any mechanical stoker. As examples of what can be achieved under the most favorable conditions, the following figures may be given:

Place.	Boiler.	Stoker.	Results. Lbs. Water per Lb. of fuel, from and at 212° F.
Bristol.	Babcock & Wilcox.	Koker.	11.20
Belfast.	"	Bennis.	11.96
.....	Solignac.	Hand-fired.	10.84

With these figures it would be useful for engineers to compare the results obtained in their own works. The author was recently told by the engineer in charge of one of the finest and largest electricity supply stations in Lancashire, that the average evaporative efficiency of his boiler plant was only about seven pounds water per pound of fuel.

Another aspect of the subject which also deserves consideration is that of the bearing of this waste of fuel upon our position as a manufacturing country. We hear a great deal at the present time about the unwisdom of exporting millions of tons of fuel per annum (from England) and thus lessening our reserves of this valuable raw material. We hear too little, however, about the millions of tons which are annually "wasted" by users in Great Britain. Supposing the author's estimate of twenty per cent loss to be correct (and most engineers would admit that as regards factories and works this estimate is, if anything, too low), the weight of the fuel which is wasted at the present time by unscientific use in this country must amount to 34,000,000 tons per annum. (The average home consumption for the years 1897-1900 was about 170,000,000 tons per annum.) This waste of a raw material so essential for our manufactures—the reserves of which will not last this country for ever—is sheer folly, and it ought to be checked with the least possible delay.

The German Electrochemical Society.

The annual meeting of the Deutsche Bunsen Gesellschaft was held at Bonn, May 12, 13 and 14. An excellent programme was provided, and among the number of valuable papers may be mentioned the following: "The Application of the Phase Rule to the Mixture of Iron and Carbon," by Professor Roozeboom; "Electrochemical Reductions," by Professor Elbs; "The Ruthenburg Electrical Concentration and Reduction Process for Iron Ores," by Dr. H. Goldschmidt; "The Passive State of the Metals," by Dr. Wolf-Müller.

The Bunsen Gesellschaft may be represented at the International Electrical Congress, to be held in St. Louis next September. This would probably make it possible to hold a triple meeting of the three electrochemical societies—the American, the Faraday and the Bunsen—as the Faraday Society will doubtless also be represented.

Water Power of the Rhine.

The success of the power station at Rheinfelden has been so great that steps are now being taken to obtain more power from the Rhine at this point. There are three falls on this river, near Rheinfelden. The first is the only one that has been used up to this time. It is now proposed to carry out large civil engineering works, which will utilize the other two falls. These falls will be combined to give a head of from twenty-six to forty feet, according to the state of the river. There is an island in the river at this point, the river itself forming the boundary line between Switzerland and Germany; therefore, one-half of the works will be situated in Germany, and the other half in Switzerland. It is at present intended to devote the whole of the original works to the manufacture of aluminum. The present plant has a capacity of 16,800 horse-power in water turbines, and 1,400 horse-power in steam turbines. The new stations utilizing the second and third falls will have an aggregate output of 30,000 horse-power, and will distribute electrical energy throughout the towns of Basle and Rheinfelden, respectively.

ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

FIRE RISKS AT SWITCHBOARDS.

The fires which have taken place at Bristol and other places are full of warning for mining people. Switchboards at collieries and at metalliferous mines are particularly liable to fire risks. There is always so much coal and ore dust flying about in the atmosphere, and so many ledges where it may deposit unnoticed, leading to the formation of high-resistance bridges, between surfaces where considerable difference of pressure exists; the result being that the bridge is burned, an arc following. Switches in engine houses underground are subject to the same thing. A colliery manager told me of a case where the switch of a pump set fire to the covering of the cable connected to the switch, with the result that the engine house was set on fire, and they had great difficulty in getting it under, the wave of smoke coming back against the air current. There are many substances that cold-storage men have brought into use for insulating cold stores that could be usefully employed in the manufacture of switches and switchboards.

ELECTRIC WINDING AT 1,000 VOLTS, WITH THREE-PHASE MOTORS.

At the Noel-Sart-Culpart colliery, in Belgium, an electric winding plant has been installed, under rather peculiar conditions. It was necessary to sink what in the north of England is called "a staple pit"; that is, a small pit connecting one seam with another, at a point some distance into the workings. The pits of the kind which have been sunk in this country are usually only fifty yards deep, or thereabouts. The one at Noel-Sart-Culpart colliery is 133 yards deep, and it is 550 yards from the main shaft. It is worked by the usual two winding drums, one for each rope, the drums being driven by a three-phase motor, supplied with current at 1,000 volts. As in all winding apparatus, the two drums revolve in opposite directions, one winding up the rope of the cage which is ascending, and the other paying out the rope of the cage which is descending. The two drums are connected together mechanically, and in this case one of them carries a pinion-wheel, while the other carries the brake. The pinion-wheel gears into the spur-wheel on the intermediate shaft, the pinion-wheel on this gearing into the spur-wheel on the motor-shaft, in the usual way. The motor is stated to be of the revolving field type, and to be of 125 rated horse-power, but to be capable of developing 300 horse-power as a maximum, for starting. It will be remembered that the difficulty of the problem in winding arises from the fact that the load is constantly changing throughout the duration of each wind. At starting, a very heavy effort has to be exerted to start the cage from rest at the pit bottom. As the wind proceeds, the constantly lessening length of the ascending rope and the constantly increasing length of the descending rope, coupled with the continually increasing momentum of the descending cage, gradually lessen the load, till after a certain point in the shaft has been passed by the descending cage the engine has no work to do. It has in fact to control the work being done by the descending cage. The motor runs at 415 revolutions per minute, and its speed is regulated by inserting resistances in the rotor circuit, and, where necessary, by reversing the direction of the revolving field. It is stated that the speed can be reduced from 13.75 feet per second, the maximum, to four inches per second, by this means. This arrangement also forms the brake, used when men are being lifted. In addition, there is a mechanical brake on the intermediate shaft, applied by the foot, in the usual way, and an emergency brake, applied by a weight carried at the end of a lever, which is released automatically in case of necessity. One of the features of the arrangement is that for regulating the pressure, under the varying conditions of the load. The excitation rheostat of the generator is controlled by three-phase motor, at the back of the switchboard. Presumably, when the speed of the engine is lowered, or the pressure at the terminals of the generator is lowered, from any cause, the regulating motor takes resistance out of the exciter circuit, and vice versa, and so maintains the pressure delivered to the service fairly uniform. It is stated that the pressure does not vary more than one per cent, which may be taken to be exceptionally good. The generator is belt-driven, and the exciter is also belt-driven from the generator.

Another feature in connection with the Belgian installation is the lights in the engine house on the surface, and in the buildings in its neighborhood which are supplied from the exciter dynamo, which is worked at 110 volts. The control of the winding apparatus in the "staple pit" underground is entirely by the usual barrel controller, the barrel being filled with oil; and the arrangement is stated to work very satisfactorily. It is worth noting, however, that while three-phase current is delivered to the motor which drives the winding drums at the full pressure of 1,000 volts, the pump, a three-throw ram of the usual pattern adopted for colliery working, is driven by a motor at 120 volts, the pressure being reduced by a transformer fixed in the winding engine house. The winding-engine house is cut out of the coal, as usual, and lined with masonry, a certain space being left all round the apparatus, sufficient to allow of a man going round it without danger. The frame of the motor and the cases in which the fuses are enclosed are connected to earth. The fuses are enclosed in gas-tight boxes, and the slip rings of the winding motor are also enclosed in a gas-tight box. The fuses are of a novel pattern. The fuse is enclosed in a micanite tube, which is again enclosed in a porcelain tube, forming the handle. A telephone is fixed between the engine house at bank and the winding engine house underground. There is a switchboard in the winding engine house underground, consisting of marble slabs mounted in an iron frame, and carrying the measuring instruments and switches.

WINDING BY ELECTRICITY.

Considerable interest is being taken in the question of winding by electricity in Great Britain as well as on the Continent. The council of the South Wales institution has recently awarded a prize of £20 to one of its electrical members for a paper on electric winding. Mr. W. C. Mountain, of Ernest Scott & Mountain, of Newcastle, who has done a good deal of electrical work in mines, has recently made a tour in Germany for the purpose of seeing what our German confrères are doing in the matter of winding by electricity, and he has communicated the result of his observations to the North of England Institution of Mining Engineers. Mr. Mountain describes two installations in particular, one at the Zollern colliery, where the Siemens-Ilgner system is used, in which the special feature is the storage of the energy delivered to the winding drum by the descending cage, during the latter part of the wind, in the heavy fly-wheel which is carried between the motor and generator of the motor-generator converter. At the Preussen colliery, on the other hand, the winding drum is driven by a three-phase motor, which takes its current directly from the electric service of the colliery, at 2,000 odd volts. In both collieries the Koepe system is used, which partially neutralizes the advantage of the flywheel system. In the Koepe system the rope is always the same length, at every part of the wind. In place of the rope coiling up on a drum, when it is not supporting the cage at some distance

in the shaft, each cage hangs in a loop of the rope, the remainder of the rope hanging down the shaft, and passing under a pulley at the bottom, so that as the cage ascends the loop in the shaft increases, and *vice versa*. With the ordinary arrangement of winding, the rope is coiled on the drum when the cage is at the top of the pit, and is uncoiled as the cage descends, so that when the wind commences there is a certain weight, consisting of the cage and the coal, and the rope, to lift, but as the wind proceeds, the rope decreases in length, and therefore in weight, while the length and weight of the rope attached to the descending cage are increasing. With the Koepe system this is neutralized. In addition to the varying length of the rope, there is the varying momentum; that acquired by the descending cage constantly increasing. The great trouble with the direct-driving of the winding drum is stated to be the very heavy drop in pressure, in the supply current, when the wind is on. The drop was as much as from 2,300 to 1,600 volts, when Mr. Mountain was at the colliery. The arrangement appeared to require two generators, to be constantly running to provide for the drop caused by the winding motor. It is instructive to note that the current taken by the three-phase direct-connected motor was the same as that of the Siemens-Ilgner system, though the pressure with the latter was only 520 volts, and with the former 2,300 volts, *viz.*, about 300 to 450 amperes. There are several points of interest in Mr. Mountain's description. With the direct three-phase driving, the exciter of the generator was a motor-generator, the motor receiving current from the supply service. The starting switch of the motor controlled a rheostat included in the rotor circuits by means of the usual slip rings, the pressure in the rotor never exceeding 300 volts. The rheostat consisted of three electrodes which dipped into a solution of soda, but instead of the plates being raised and lowered, the liquid was forced up into the vessel in which the plates were held, the solution being pumped into the resistance tank by a centrifugal pump. Another point of interest is, at the Zollern colliery, where the Siemens-Ilgner system is in use, the engines driving the generators are triple expansion, the steam pressure at the stop valve being 147 pounds per square inch. The pressure in the high-pressure cylinder was ninety-six pounds; in the intermediate, 42.5 pounds; in the low-pressure, 20.5 pounds, and the vacuum, 11.8 pounds. At the other colliery the engines were cross-compound, the steam pressure being 125 pounds per square inch. Both engines are what would have been termed in old days slow-speed, as they both run at under 100 revolutions per minute, but it is interesting to note that the piston speed in each case is over 600 feet per minute. The standard, it will be remembered, used to be 300 feet per minute.

Report of the Executive Committee of the Railway Test Commission.

A full meeting of the executive committee, appointed to determine the nature and scope of the electric railway tests to be made at St. Louis and elsewhere during the coming summer, was held at St. Louis on Friday and Saturday, May 6 and 7. The committee consists of Professor W. E. Goldsborough, chief of the department of electricity, Universal Exposition, chairman; Professor H. H. Norris, Cornell University, superintendent of electric railway tests; Professors B. V. Swenson, University of Wisconsin, and H. T. Plumb, Purdue University, assistant superintendents of electric railway tests.

After careful study of the reports of the engineering committees, of the suggestions of the advisory committee, and of the excellent facilities afforded by the exposition officials, the executive committee decided to undertake the following series of tests:

(*a*) Tests on the service capacities of electric railway motors.

Equipments will be operated upon the special tracks at different rates and durations of acceleration, coasting and braking, with different lengths of stops, in order to determine the heating of the motors under conditions approaching as nearly as possible those of commercial practice. The motors will also be tested separately for heating and for the determination of their torque curves and accelerating power. This will render possible the comparison of the performance of the same equipment upon the track and upon the test stand.

(*b*) Acceleration tests.

Acceleration tests upon single cars and upon multiple-equipped trains will be made to determine the ability of the equipment to bring the cars to speed quickly and economically.

(*c*) Braking tests.

Braking tests upon single cars and multiple-equipped trains will be conducted in order to determine the quickness of action, the shapes of the braking curves, the relation between the braking forces and the applied pressures and the best methods of application of the braking forces.

(*d*) Tests upon train resistance.

Determinations of the resistances due to the rails, to the journals and gearing and to the air will be made by systematic and complete series of runs. The effect of the shape of the car body will be carefully investigated. The methods to be used in measuring train resistance comprise the use of calibrated motors as the sources of power, the hauling of the car under test by calibrated dynamometers, and by noting the falling off in speed while the cars are coasting. The pressure of the air upon different parts of the car will be recorded by means of self-registering pressure gauges.

In addition to this definite series, a number of other tests will be conducted upon various exhibits in the Palace of Electricity in order to determine their efficiency and reliability.

Sections (*a*), (*b*) and (*c*) of the tests will be carried on upon the tracks which have been built for the purpose by the exposition. These are of substantial construction, conveniently located, and of a total length of about 4,500 feet. For the tests described under section (*d*) the Indiana Union Traction Company has provided a stretch of eight miles of straight and heavily ballasted track. The resistance tests will be made after the completion of the St. Louis programme.

In all of the above work, graphical records of the measurements will be obtained by the use of autographic instruments which will be built for the purpose or supplied through the cooperation of the manufacturing and operating companies and the technical colleges. The National Bureau of Standards will materially aid in this work by providing facilities for the calibration of all of the instruments.

For the purpose of comparison, the various railway equipments will be divided into several classes including car weights up to forty-five tons, as follows:

(*a*) Light city service equipments.

(*b*) Heavy city service equipments.

(*c*) Light interurban service equipments.

(*d*) Heavy interurban service equipments.

The actual work of observation and calculation will be carried on under the personal supervision of the superintendents by a corps of young men carefully selected from among the graduates of leading technical schools, the total number of observers being between thirty and forty. The exposition management is cooperating enthusiastically with the railway test commission in providing ample facilities for the tests, and substantial results of permanent value to the profession are confidently expected.

At the present time a large part of the equipment is already at St. Louis, the organization, and the ranks of the testing corps have been filled with earnest young men who mean business and who are already fitting themselves especially for the tasks before them.

Reviews of Current Engineering and Scientific Literature.

Continuous-Current Transformers.

Continuous-current transformers are not used to any great extent, the chief reason for this being due to the impossibility of obtaining a variation of voltage by inserting a resistance in the shunt winding, the only method of varying the voltage being to introduce a resistance in the main circuit of the dynamo or motor windings. Occasionally a case arises when such regulation is not necessary, and here a continuous-current transformer—that is to say, one machine having two armature windings—may be used to advantage. The advantages of the continuous-current transformer, compared with the motor-generator, are the higher efficiency due to reduced friction losses and field losses, and a lighter machine may be used, since the armature reaction is reduced to a minimum. The author, Mr. J. W. Burleigh, outlines the method to be followed in designing such machines, and applies his method to a two-kilowatt transformer. Bearing in mind the requirements for a continuous-current transformer, the design may be made much simpler than that of a dynamo. Cast iron may be used for the field circuits, since a small field only is needed. There is no necessity for a bed-plate, so that the feet may be cast solid with the field. Copper brushes may be used, and a high efficiency should be sought—at least ten to thirty per cent higher than a motor-generator of similar output.—*Abstracted from the Electrical Engineer (London), April 29.*

Improved Method of Charging Internal Combustion Engines.

When the pistons of the gas and air pumps which are used to charge an internal combustion engine are driven from the same crank-shaft and arrive at their dead points simultaneously, they move always in the same direction to each other—that is to say, at each instant the proportion between the quantities theoretically pumped by the two pumps remains the same. The ratio between the quantities of air and gas pumped theoretically is the same as the ratio of the areas of their pistons. When combustible gas varies considerably in calorific value, it is advantageous to be able to vary the ratio of gas to air, in order to retain that most favorable for combustion. As the area of the pistons can not be varied, the stroke of the pumps, or of one of them, must be varied. A method of accomplishing this has been developed by Korting Brothers, of Linden, Germany. The pumps are double-acting and are operated from the same reciprocating rod, actuating rocker-arm. By an arrangement, the connecting rod which operates the piston of one of these pumps can be shifted along the rocker-arm. In this way its throw is varied at will. By another arrangement the motion of the shaft is transmitted to a double bell crank, from which the two pumps are operated. A simple arrangement allows both connecting rods to be shifted simultaneously, and thus adjust the throw of the two pumps in opposite directions, producing the desired change in proportions of gas and air with minimum motion.—*Abstracted from the Mechanical Engineer (London), April 30.*

The Palermo-Rocca-Monreale Electric Tramway.

The celebrated city of Palermo, which until recently had only a horse-car system, now has a complete electric system installed by the Siemens-Schuckert Company, and which is here described by M. E. Guarini. The total length of the line is thirty-two kilometres, and it is operated from a steam station containing three 300-kilowatt dynamos. The rolling stock consists of seventy motor cars. The old horse-cars are used as trailers. The chief novelty in this system consists in a small cable road, operated electrically, which assists the cars over one of the steep grades of the system. The grade of this section is about twelve per cent, and it is 1,200 metres in length. The cable equipment consists of a cable passing around a fixed wheel at the top of the grade, and having attached to each end two electric locomotives. At the lower end of the grade is a pit, into which these locomotives descend, passing between the running rails of the car, so that the cars may pass over them. The rails on which the locomotives run lie between the other rails. When a car is to be carried up the grade, it passes over the small locomotive, stopping just beyond the pit at the foot of the steep grade. The schedule is arranged so that there will be another car descending at the same time. This, in coming down the track, couples on to the locomotive at the top of the grade. The two then descend, and in doing so draw up the other locomotive which is at the bottom of the grade in the pit, until it is coupled to the car which is to be carried up the grade. The two trains pass at a turnout about the centre of the grade. When the extremities have been reached, the locomotives are detached, allowing the cars to proceed. These locomotives weigh 7.9 metric tons. The weight of the motor cars, loaded, is about ten tons. The maximum slope of this incline is 13.17 per cent, this being 200 metres in length.— *Translated and abstracted from the Revue de l'Électricité (Lausanne), April 30.*

Asbestos and Its Uses.

Asbestos, being one of the best fire-resisting materials known, is becoming of considerable importance in engineering work. This mineral is found in all quarters of the globe. The only kinds so far found possible for what may be termed universal commercial purposes are the Italian and Canadian varieties, although the Russian and the South African specimens have their uses in a more limited field of operation. The Italian and Canadian varieties contain about one-third magnesia and about forty per cent of silica, the other constituents being iron, potash, soda and alumina. The peculiar characteristics of this material are that it is fibrous, fireproof, an insulator, and a non-conductor of heat, and is also acid-resisting to a great degree. In working up the material, the treatment varies according to the quality of the mineral and the purpose for which it is intended. The blocks of fibre are crushed and opened in machines, in such a way as not to destroy the fibre. They are then passed to shaking machines, where the long fibre suitable for spinning is separated from the short. The long fibre is then passed through the carding and condensing department, and from here on the treatment is similar to that followed in a textile factory, though the peculiar character of the material makes special machinery and treatment necessary. The shorter fibre, suitable for making millboard and paper, is beaten up in pulp machines and treated in much the same way as paper pulp. The asbestos found in South Africa has a blue fibre, and differs from the Italian and Canadian varieties, in that the magnesia is replaced largely by oxide of iron, of which it contains forty per cent. Silica forms fifty per cent of the material, the other con-

stituents being alumina and magnesia. The fibre in this mineral is longer than in the Canadian. It is also stronger and lighter, and is not as easy to manufacture. Also, on account of the quantity of the oxide of iron, it is not suitable for many purposes for which the other is used. Asbestos is also found in the form of powder, this kind occurring in Italy. The powder is worked up into various kinds of fireproof paint.—*Abstracted from the Electrical Review (London), April 29.*

Notes on the Design of Electrical Machinery.

Various writers have suggested that a difference should be made in the designs of continuous-current machines, between those built for 100 or 200 volts and those intended for 500 volts. Generally speaking, the output of a machine for low voltage is limited by the temperature rise in the armature, there being no difficulty in securing good commutation. With 500-volt machines, much care is needed in the design of the commutator, to obtain a machine in which the output will not be limited by the operation of this part. This requires that a special design be made. The author of this paper, Mr. Louis J. Hunt, admitting the desirability of this, believes that, in order to simplify the work at the factory, the design for the 500-volt machine should be adopted for the lower voltages. He then discusses the question of armature design, with reference to obtaining good commutation. The electromotive force induced in a short-circuited coil opposing commutation may be said to be proportional to the armature ampere-turn per pole, to the number of turns per commutator part, to the speed of the machine in revolutions per minute, and to the length of the core. This condition may be written in the following way: $\delta = AT\,p\,. \times T \times L \times R \times K$, in which AT p is equal to the armature ampere-turns per pole, T the armature turns per commutator segment, R the revolutions per minute at which the armature is running, L the length of armature core in inches, and K a constant, l for loop-wound armatures and P/2 for wave-wound ones, with two sets of brushes. For slotted armatures the limiting value of δ may be taken as 6×10^7. A figure as high as 8×10^7 will give sparkless commutation, if a hard quality of carbon brush be used and a large brush lead is not objectionable. This equation is applied to the analysis of several machines, and it is shown that in one case where, under normal conditions, the machine sparked badly, by decreasing the speed it carried the full load without any difficulty. The question of commutator losses is discussed, attention being called to the fact that if the commutator losses are to be reduced to a minimum, the contact surface of the brush should be so chosen that the loss due to friction is half that due to the ohmic resistance at the contacts. Some considerations in the design of alternating-current machines are touched upon, particularly the effect produced upon the voltage regulation of the generator by the demagnetizing effect of the armature, this effect being greater than that due to the inductance of the armature windings. The method of computing this effect is given, and is applied to a practical case.—*Abstracted from the Electrician (London), April 29.*

Blast-Furnace Gas Engines.

The utilization of blast-furnace gas for gas engines was suggested by H. E. Thwaite ten years ago. To-day there are a large number of such stations operating in Germany. The author of this article, Mr. Percy R. Allen, has studied this problem, and has come to conclusions agreeing entirely with those of Thwaite. He finds that a furnace making seven tons of iron per hour, or 168 tons per day, generates enough gas to furnish 5,880 horse-power continually, after having deducted what is necessary to heat the blast and to work the blowing engine. He assumes that the gas be utilized in gas engines of high efficiency, taking from 90 to 100 cubic feet of gas per horse-power-hour at full load. The author describes the various types of European gas engines which have been developed for this purpose. The Cockerill engine, manufactured by the John Cockerill Company, of Seraing, near Liege, Belgium, is a four-cylinder engine, two cylinders being placed on each side of the flywheel. The old form of gas engine manufactured by the Gasmotoren Fabrik Deutz had the cylinders placed vis-a-vis, the first pair being duplicated for larger sizes. There were some practical difficulties in this arrangement, and these engines are now built with cylinders closed at each end, operating on the Otto cycle at each side of the piston. The Nurnberg engine is another design largely used in Germany. It also has a closed cylinder with a double-acting Otto cycle. The Korting engine is a two-cycle machine. In this there is an impulse imparted to the piston at every stroke. The Ilseder Hutte engine has an open cylinder with two pistons, each moving in opposite directions. Certain of these companies are prepared to build gas engines for direct-coupling to generators up to 6,000 horse-power. One of the difficulties in utilizing blast-furnace gas is washing out all dust. The most successful devices for this purpose are due to Thiesen and to Clemang. Thiesen's washer consists of a large drum, within which a second drum revolves. The gas is drawn axially through this apparatus by a fan placed at one end, and in its passage is washed by jets of water thrown out from the inner drum. This device both cools the gas and washes it, reducing the solid matter to a smaller percentage than that in the surrounding atmosphere. This device requires a considerable amount of power to drive it, amounting often to eight per cent of the output of the engines. The Clemang purifier is a vertical apparatus with a kind of helical blade throwing the injected water against the sides of an annular casing. It is said that this device requires a small amount of power to drive it. The author says that the development of the Kent coal field and the reworking of the Sussex iron-ore deposits, in combination with foreign ore brought in bulk to Dover, would mean that enough power would be generated within forty or fifty miles of London to drive every street car and railway in the metropolis.—*Abstracted from the Electrical Magazine (London), April 26.*

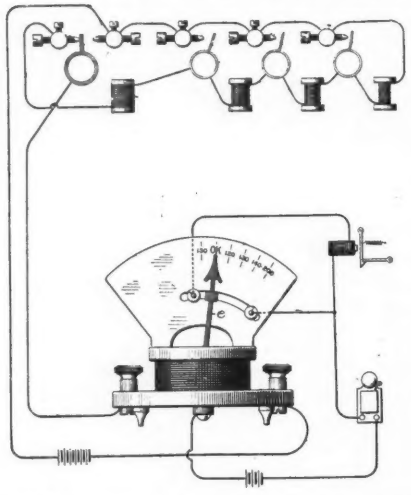
Electrical Industry in Great Britain.

The British *Trade Review* reports that the electrical engineering firms of that country have a satisfactory amount of work on hand for power, traction and lighting. Among the firms most extensively employed are the British Westinghouse Company, at Trafford Park; Messrs. Mather & Platt, of Southford, and Messrs. Dick, Kerr & Company, of Preston. The rapid extension of electric tramways in Great Britain and abroad is continually bringing new orders, and firms with specialties in track equipment, cars and safety appliances have few idle departments.

The same publication reports an increased demand for coal-cutting machinery in mines. Great improvements are being made in the South Lancashire pits, in ventilation, haulage and coal-cutting, and the electric power companies which are erecting power stations in various parts of the country are likely to have a profitable field in the supplying of electricity, not only to the mining, but to other industries, especially to cotton mills.

Electrical Patents.

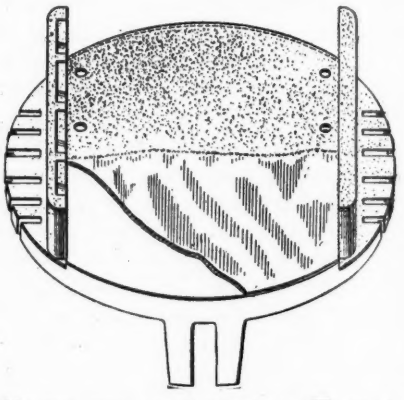
An electric system for indicating the temperature at a distant point has been devised by Mr. Robert G. Callum, of Washington, D. C. While the system is intended for indicating the temperature at a distant point, it is more especially devised for indicating the temperature of distant compartments or rooms provided for the storage of coal or other material, and for giving an alarm should the temperature of such compartments or rooms reach a point dangerous to the material or goods stored therein. It is to be understood, however, that a system embodying the invention is adaptable for use wherever it may be desirable to indicate the temperature of a distant point. The main objects sought are, first, the production of a simple and reliable system that may be



An Electric System for Indicating the Temperature of a Distant Point.

readily adjusted to suit particular requirements; and, second, a system which will itself show whether variations in the indicating device have, in fact, been caused by variations in temperature at the distant point or by an accidental derangement of the system or apparatus employed therein. To accomplish the ends sought, the inventor has provided two or more separately adjustable thermostats which are connected in series in a normally closed electric circuit, the thermostats being located at the distant or guarded point and each being adjusted and arranged to establish shunt circuits at predetermined different degrees of temperature for decreasing or increasing resistance in the main circuit. Connected in the circuit at the point where the temperature is to be read is a galvanometer or other current-measuring device which will indicate variations in the normal current or circuit. The adjustment and the resistance controlled by each thermostat being known, the position of the indicator of the current-measuring device will indicate the temperature at the distant point. By the employment of two or more separately adjustable thermostats the particular degrees of temperature to be indicated may be changed to suit particular requirements, and the failure of one thermostat to operate can not interfere with a proper operation of the others. In all prior systems wherein resistance in an electric circuit is varied by thermostatic devices for indicating by means of a current-measuring device variations in temperature at a distant point, no provision has been made for distinguishing between variations in resistance caused by the operation of the thermostatic devices and variations that may be caused by accidental derangement of the system or apparatus—as, for instance, an accidental crossing of wires—which might cause the current-measuring device to indicate a dangerous degree of heat when in point of fact the temperature at the distant point is normal. In order that it may be positively known whether variations in the indicating device have been caused by variations in temperature or by accident, provision is made for automatically opening the circuit at a predetermined temperature and again closing it at a different degree of temperature, so that it may be known that the system is in proper working order. There is also provided a device for registering the opening of the circuit, the temperature of the device serving as record proof of the character of subsequent variations in the indicating device.

Mr. George Westinghouse, of Pittsburg, Pa., is the assignee of a patent granted Messrs. Alexander Jay Wurts and Edward Bennett, also of Pittsburg. The invention relates to electric lamps of the type in which the light-emitting bodies or glowers are conductors only when hot and in which the leading-in wires or the conductors employed for heating the glowers, or both, become more or less disintegrated in use, so as to produce a conducting deposit upon adjacent non-conducting parts. The object of the invention is to provide a means whereby the non-conducting portions of the lamp which constitute supports for the glowers and heaters may be continued in service for an indefinite period without experiencing any material losses and without impairing the operation of the lamp. In the operation of the lamps, of the character above indicated, difficulties have been experienced where platinum leading-in or heating conductors, or both, have been employed by reason of the formation of platinum-black and the deposition of it upon the non-conducting parts of the holder. The platinum-black thus deposited is a conductor and frequently establishes short-circuits, which result in damage to the parts of the lamp between which such short-circuits are established. In order to obviate this difficulty, the inventors have devised the means constituting the present invention. The holder comprises a disc, of porcelain or other suitable non-conducting and heat-resisting material, having on one side lugs for supporting the holder in proper position, and on the opposite side lugs between which the heater tubes are supported. The terminal leads from the heater coils project through holes in the plate and are attached by suitable binding devices to terminal rods or blocks at the other side of the disc. The glower leads extend through the slots in the edges of the disc and are also attached by means of suitable binding devices to the proper terminal rods or blocks at the other side of the disc. All of these parts are well known to the art, and therefore they, as well as the cooperative relation between them and the heaters and glowers, need not be more fully described. The platinum-black that is formed during the operation of the lamp becomes deposited upon the non-conducting parts and, as has been already stated, if allowed to remain on the holder is likely to cause dam-



Holder upon and Adjacent to Which the Heaters and Glowers Are Supported.

age by reason of the short-circuits which may be thus established between different conductors. It has been found practically impossible to remove the platinum-black from the porcelain holder, when deposited, as indicated, and a holder is therefore provided on the heater and glower supporting side with a coating of suitable non-conducting paste, which may or may not be baked after it is applied, as may be found desirable. A paste formed of a mixture of kaolin, alumina and water has been used and found satisfactory in practice; but a paste formed of other non-conducting materials might be used which would be equally satisfactory. The chief requirement in this connection is that the non-conducting paste shall adhere to the porcelain sufficiently well to permit of handling without being accidently broken away, but shall still be easily removable. The coating, if of suitable material and properly applied, may be readily scraped or brushed off when the lamp becomes substantially inoperative. A new coating may then be applied and the holder be again put into service.

The Convention of the National Electric Light Association.

The Twenty-seventh Annual Convention of the Association to Be Held at Boston, Mass., May 24, 25, 26 and 27.

THERE is every indication that the twenty-seventh convention of the National Electric Light Association will be one of the best attended in the latter history of the association. That it will be productive of good results is assured by the fine programme which has been announced, and there is no doubt but that the untiring work of the president and various committees will meet with commensurate appreciation. Not only is there a list of papers which, for variety and attractiveness, seems second to none, but the entertainment features are such as will provide ample opportunity for enjoyment during the course of the convention session. The following programme has been announced:

TUESDAY, MAY 24, FIRST SESSION, 10 O'CLOCK A. M.

President's address, Mr. Charles L. Edgar, Boston.

Report—"Progress," editor, Mr. T. Commerford Martin, New York.

"A Three-Wire, 500-Volt Lighting System," Mr. Walter I. Barnes, Providence.

"Luminous or Flaming Arc," Mr. Welles E. Holmes, Newton.

Committee on standard candle-power of incandescent lamps, Dr. Louis Bell, Boston, chairman.

Committee on legislative policy, Mr. Samuel Insull, Chicago, chairman.

Committee on photometric values of arc lamps, Mr. Henry L. Doherty, Denver, chairman.

Committee on uniform accounting, Mr. Guy L. Tripp, Boston, chairman.

SECOND SESSION, 2 O'CLOCK P. M.

"A 100-Mile Transmission Line," Mr. Robert Howes, Spokane, Wash.

"Grounding the Neutral of High-Voltage Generators," Mr. George N. Eastman, Chicago.

"Remote Control of Electrical Apparatus," Mr. William H. Cole, Newton.

"The Organization and Equipment of an Arc Lamp Department," Mr. Samuel G. Rhodes, New York.

"Electric Heating," Mr. James I. Ayer, Cambridge.

Report—"Lost and Unaccounted-for Current," Mr. C. W. Humphrey, Denver.

WEDNESDAY, MAY 25, THIRD SESSION, 10 O'CLOCK A. M.

"Economy in Minor Station Supplies," Mr. Edgar B. Greene, Altoona, Pa.

"Notes on the Internal Combustion Engine as Applied to Central Station Service," Mr. E. E. Arnold, Pittsburg, Pa.

"Economy Test of a 5,500-Horse-Power, Three-Cylinder, Compound Engine and Generator," Messrs. J. D. Andrew and W. F. Wells, New York.

"The Mechanical Stoker and Human Operator," Mr. Edwin Yawger, Pittsburg.

Committee on award of Doherty gold medal, Dr. Schuyler S. Wheeler, Ampere, N. J., chairman.

Report—"Investigation of Steam Turbines," Mr. W. C. L. Eglin, Philadelphia, chairman.

"Practical Notes on Steam Turbines," Mr. Francis Hodgkinson, Pittsburg, Pa.

THURSDAY, MAY 26, FOURTH SESSION, 10 O'CLOCK A. M.

"Electric Light and Power Plants in Connection with Ice Plants," Mr. C. L. Wakefield, Dallas, Tex.

"Report on Sign and Decorative Lighting," Mr. Arthur Williams, New York.

"Report on Advertising," Mr. La Rue Vredenburgh, Boston.

"Report on Purchased Electric Power in Factories," Mr. W. H. Atkins, Boston, chairman.

"Report of Committee on District Heating," Mr. E. F. McCabe, Lewiston, Pa., chairman.

"Report on Office Methods and Accounting," Mr. Frank W. Frueauff, Denver.

FIFTH SESSION, 2 O'CLOCK P. M.

"A Proposed System of Standard Instruments for Operating Companies," Mr. H. P. Davis, Pittsburg, Pa.

"Single-Phase Power Motors for Electric Lighting Stations," Mr. W. A. Layman.

"Report on Analysis of Flue Gases," Mr. Henry L. Doherty, Denver, chairman.

Extra.

Wrinkles, editor, Mr. Charles H. Williams, Madison, Wis.

Question Box, editor, Mr. H. T. Hartman, Philadelphia, Pa.

SIXTH SESSION, 8 O'CLOCK P. M.

"Types of Large Water-Power Installations," with stereopticon, Dr. F. A. C. Perrine, Pittsfield.

Executive Session.

The following named gentlemen comprise the local entertainment committee:

James I. Ayer, chairman, Professor C. A. Adams, Albert Anderson, William H. Atkins, F. E. Barker, F. P. Barnes, R. N. C. Barnes, George H. Berg, H. Bottomley, Captain William Brophy, F. E. Cabot, C. W. Cartwright, A. E. Childs, A. T. Clark, Professor Henry E. Clifford, D. P. Robinson, Charles B. Davis, George C. Ewing, H. H. Fairbanks, H. C. Farnsworth, George H. Finn, Almon Foster, W. C. Fish, Charles J. Hatch, Percy Hodges, W. E. Holmes, G. W. Holtzer, Sidney Hosmer, P. J. Kennedy, A. H. Kimball, George B. Lauder, F. W. Lord, Emil O. Lundin, Norman Marshall, E. H. Mather, Everett Morss, H. W. Moses, W. L. Mulligan, J. H. Parker, H. S. Potter, C. B. Price, C. F. Pritchard, Andrew Raeburn, F. H. Raymond, F. S. Richardson, S. B. Condit, Jr., Frank Ridlon, F. P. Royce, G. L. Sadler, F. S. Sias, F. E. Smith, Professor H. B. Smith, J. A. Smith, J. Brodie Smith, George R. Stetson, F. J. Stone, G. M. Stuart, La Rue Vredenburgh, Thomas C. Wales, R. L. Warner, N. T. Wilcox, S. B. Wetherbee, F. S. Wilson, W. C. Woodward.

The following programme will be carried out for the entertainment of the visitors:

On Tuesday afternoon the ladies in attendance will take carriages and drive through the Fenway and possibly to some points of interest about Boston. Committee—Charles J. Hatch, W. E. Holmes, D. P. Robinson.

On Tuesday evening there will be given at Hotel Vendome a lecture on "Historical and Electrical Boston," under the charge of La Rue Vredenburgh.

On Wednesday morning the ladies will visit the shopping district. Committee—H. S. Potter, F. S. Wilson, F. S. V. Sias.

On Wednesday afternoon there will be a trip down the harbor, and on return a visit to the L street station of the Boston Edison Company. Committee—Sidney Hosmer, Percy Hodges, W. C. Woodward, Professor H. E. Clifford.

Wednesday evening will be spent at Symphony Hall, attending a popular concert. All the space within the rail has been reserved for the use of the guests and their friends. Committee—R. L. Warner, Thomas C. Wales, R. N. C. Barnes, George C. Ewing, F. W. Lord.

On Thursday there will be provided for the ladies a trip in automobiles to Wayside Inn, Lexington and Concord. Committee—C. B. Davis, George H. Berg, F. S. Wilson.

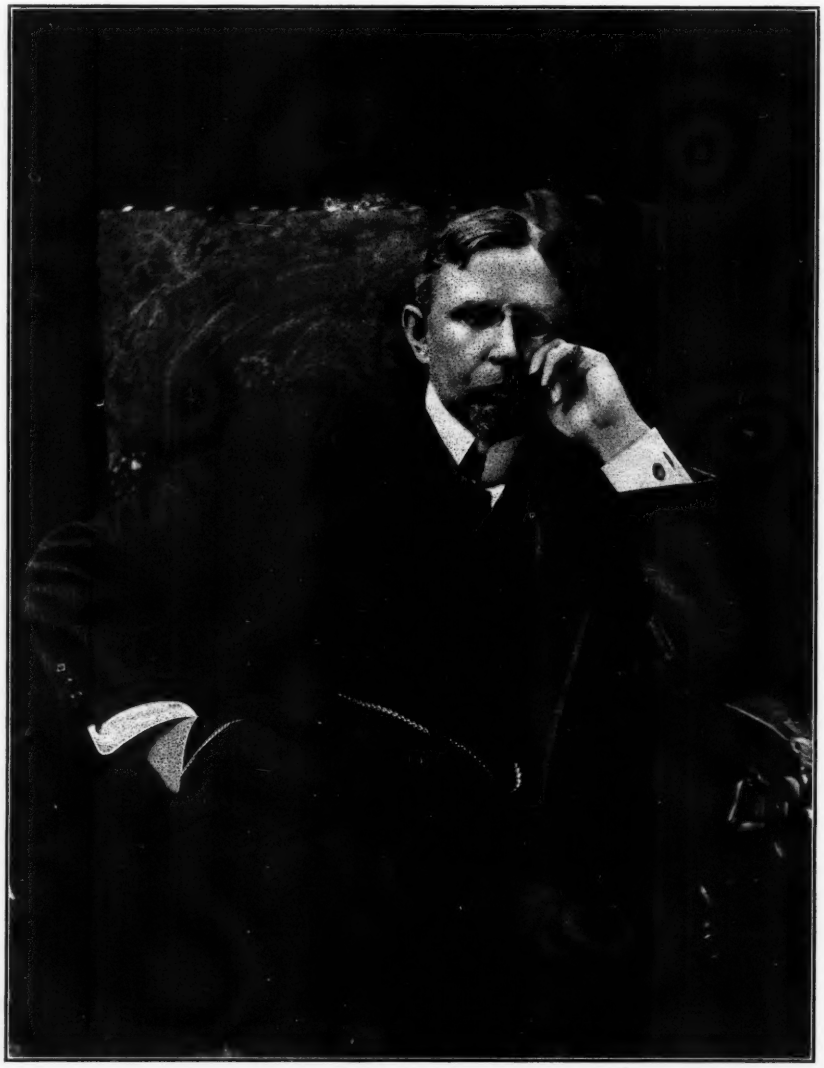
On Friday the entire day will be devoted to personally conducted trips in and about Boston. The business sessions of the association will close on Thursday evening, leaving Friday to be devoted purely to entertainment in the manner above outlined.

A general information bureau will be established at the Hotel Vendome, in charge of Messrs. Vose and Peasley, and in addition to the usual duties that such a bureau is called upon to perform, it is intended to have during the week lists made of those desiring to take any particular trips or see any particular points on Friday, so that adequate arrangements may be made for properly personally conducting the visitors to such places as they desire to go.

Mr. W. H. Atkins will have general charge of the entertainment on Friday, and the following committees have been selected to arrange details for the excursions as listed: Institute of Technology, Professor H. E. Clifford; Harvard University, Professor C. A. Adams; Bunker Hill Monument and Navy Yard, P. J. Kennedy; Fore River Ship and Engine Company, Charles H. Parker; Simplex Electric Company, Everett Morss; Holtzer - Cabot Electric Company, C. W. Holtzer; power stations, Boston, I. E. Moultrop; trolley trips, Paul Winsor; N. E. Gas and Coke Company, George H. Finn.

The New England Passenger Association, the Trunk Line Association, the Southeastern Passenger Association, the Central Passenger Association, and the Western Passenger Association have granted a special rate of a fare and one-third, on the certificate plan, for the round trip, from all points in their territory, for delegates and friends attending the convention. This rate is good for three days (not counting Sundays) preceding the opening of the convention and the three days following adjournment.

The Southwestern Excursion Bureau has granted a rate of a fare and one-third, on the certificate plan, for the round trip, from all points in its territory from Boston and return. This is the first time the concession has been made in this territory and is an evidence of the geographical as well as the numerical growth of the membership.



MR. CHARLES L. EDGAR, PRESIDENT OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The officers of the National Electric Light Association are Charles L. Edgar, president, Boston, Mass.; S. B. Livermore, first vice-president, Winona, Minn.; J. W. Lieb, Jr., second vice-president, New York, N. Y.; Ernest H. Davis, secretary and treasurer; H. Billings, assistant secretary and treasurer; G. F. Porter, master of transportation. Executive Committee—J. H. Perkins, C. F. Hewitt, D. P. Robinson, A. C. Dunham, P. G. Gossler, H. T. Hartman, Louis A. Ferguson, Harry Bottomley, Alex. Dow.

Mr. Charles L. Edgar.

Mr. Charles L. Edgar, president of the National Electric Light Association, was born near Princeton, N. J., December, 1860. In 1882 he graduated from Rutgers College with the degree of bachelor of arts. He took a post-graduate course in electricity at the same college, receiving the degree of master of arts in 1885 and electrical engineer in 1887. Since his early boyhood Mr. Edgar has been associated with the Edison interests, making frequent visits to the Edison laboratory at Menlo Park when a very young man. Soon after leaving college he became associated with the parent Edison company, the Edison Electric Light Company of New York, and remained with this company until 1887, when he went to Boston. He was chief engineer of the New York Edison Company, and left this position to become general superintendent of the Boston Edison Company, which was organized in 1886. Mr. Edgar rapidly worked his way to the front, becoming, in turn, general manager, vice-president and president, which office he has held with honor and distinction for the last five years. Under the administration of Mr. Edgar the Boston company has built up one of the most extensive central station systems in the United States. The company is now completing the first installation of what will ultimately be a 60,000-kilowatt turbine station in South Boston.

Besides being president of the Edison Electric Illuminating Company, Mr. Edgar is president of the Boston Electric Company, the Somerville Electric Light

Company, the Woburn Light, Heat and Power Company, the Newton & Watertown Gas Light Company and eight other central station companies. These companies are closely associated, and supply gas and electricity to Boston and adjacent townships. For three terms Mr. Edgar was president of the Association of Edison Illuminating Companies. He is president of the Massachusetts Electric Lighting Association, chairman of the Boston branch of the American Institute of Electrical Engineers, and was vice-president of the National Electric Light Association in 1890. At the time of his election to the presidency of the National Electric Light Association in May, 1903, he was first-vice-president of that organization. He is a member of the Lawyers' and University clubs of New York, and of the Art, Exchange and University clubs of Boston.

Mr. Edgar has long been one of the most prominent central station managers in the country, and has been instrumental in bringing forward may improvements in central station installations. He has gone on record as making the initial moves in the establishment of many of the accepted forms of metering and other auxiliary adaptations used to-day.

The American Institute of Electrical Engineers.

Annual Meeting for the Transaction of Business and the Presentation of Papers.

THE annual meeting of the American Institute of Electrical Engineers, which was held at the Chemists' Club, 108 West Fifty-fifth street, New York city, Tuesday and Wednesday, May 17 and 18, to a certain extent took the place of the annual convention, as, in addition to the transaction of routine business, a good number of interesting papers on various topics were presented.

The meeting was opened at 10.30 A. M. by President Bion J. Arnold, who called upon Mr. W. L. Waters, of Milwaukee, Wis., to read his paper entitled "Predetermination of Sparking in Direct-Current Machines."

Mr. Waters traced briefly the development of dynamo design, showing how improvements in this regard had so increased the output of machines as to make the effect of commutation upon rating important. He described early attempts to deduce laws governing commutation and sparking, and gave formulæ which had been developed for this purpose. Mr. Waters then explained how these formulæ were lacking, in that they did not take into consideration several effects, and he explained an empirical formula which he had deduced, in which two correction factors were introduced. These correction factors allow for the inductance of the end connections, and the inequalities due to the varying position of the coils during commutation. Limiting values for the sparking constant, deduced by means of this formula, were given. These vary considerably with changes in the type of the machine, but Mr. Waters has found that, for various sizes of one type, the formula is very satisfactory.

The second paper was also upon the question of commutation, and this was called for before the discussion was opened. This paper was presented by Mr. E. H. Anderson, of Schenectady, N. Y., and was entitled "Effect of Self-Induction on Railway Motor Commutation." In it the author described a study of commutation made by means of the oscillograph, and exhibited many diagrams, which showed great variations set up in the coil being commutated, due to the sudden breaking of the current.

Discussing this paper, Mr. Waters thought that the high electromotive force was caused by breaking the local current due to the armature field, and was not due to the self-inductance of the armature coils. In car motors the brushes are placed in a fixed position, and the field is almost constant. Therefore, it is possible to operate such a machine with three or more coils in the same slot; but railway motors form a special case, and such construction is not good with direct-current dynamos.

Mr. E. R. Douglas, of Ampere, N. J., discussed the computation of the self-induction of an armature coil, and explained the method which had been tried at the Crocker-Wheeler works. Such computations are exceedingly intricate, and to make them workable, assumptions must be made. As the first assumption, the armature coil was assumed to be circular, surrounding a spherical core. This calculation can be used as the basis for predetermining the inductance of the armature coil.

Mr. Thorburn Reid, of New York city, explained a method, calling attention to the variation in the sparking constants offered by Mr. Waters, and said that this constant depended more upon the variation in the ratio of the inductance to the product of the resistance of contact and the time of commutation, than upon the variations in the value of the current.

Mr. Anderson said, that the peculiar conditions under which railway motors operate made it possible to use a construction which otherwise would not be allowed. These motors are, on an average, working half the time, and polishing the commutators the other half. If the polishing is sufficient to smooth off the etching caused during working periods, the commutator will remain in good condition, while if it were worked continuously it would become badly pitted. For this reason it was possible to use a construction calling for many coils per slot in railway motors.

The third paper was presented by Dr. W. E. Winship, of New York city, and was entitled "On the Calculation of Line Batteries." Dr. Winship described a graphical method which he had found exceedingly useful in determining the proper size and location of batteries which are intended to float upon the line, and thus equalize the load.

Mr. F. J. White, New York city, pointed out that wattmeter readings give only the performance of the battery, and do not show the variations in current. It is important to know the variations, as these affect the position of the centre of gravity of the system.

Mr. Lamar Lyndon, New York city, thought that Dr. Winship should have included in his study the effect of the internal resistance of the battery and the variation in generator voltage. That this is important is shown by a recent case upon which he has been engaged. In determining the capacity of the booster, neglecting these effects he had obtained a rating of twenty-four kilowatts; bringing in these effects and correcting for the change in the centre of gravity thereby produced, the capacity of the booster was reduced to twelve kilowatts.

President Arnold said, that his practice in installing batteries had been to put in five to ten more cells than seemed necessary. With suitably arranged switches, it was possible to cut in or out as many of these cells as conditions required.

After the close of the discussion, an enjoyable luncheon was served, following which the members visited the subway and the Fifty-third and Fifty-ninth street

substations of the Interborough Rapid Transit Company.

The evening session was called to order by President Arnold at 8.30 o'clock, when the results of the election of officers were announced. The following officers were elected to serve for the ensuing year: president, J. W. Lieb, Jr.; vice-presidents, W. E. Goldsborough, J. J. Carty, Samuel Reber; managers, H. G. Stott, L. A. Ferguson, J. G. White, S. S. Wheeler; treasurer, G. A. Hamilton; secretary, Ralph W. Pope.

Secretary Pope read abstracts from the report of the board of directors, which showed the flourishing condition of the Institute and the progress made during the past year. The total membership is now over 3,000.

The report of the treasurer showed a substantial financial condition.

Mr. C. F. Scott, of Pittsburg, Pa., chairman of the committee on local organization, reported upon the excellent success with which the efforts of the committee had been met. He showed how the Institute was gathering strength throughout the country, and was at last becoming a truly national organization.

Mr. Calvin W. Rice reported for the building committee, and urged the members to put forth every effort to raise the $200,000 necessary to secure the land on Thirty-ninth street, on which the engineering building is to be erected.

The paper of the evening was by Mr. B. G. Lamme, of Pittsburg, Pa., and was entitled "Data and Tests on a 10,000-Cycle-per-Second Alternator." This was read by Mr. F. D. Newbury, of Pittsburg. The paper describes the construction of the machine built by M. Leblanc, as well as some very interesting tests which had been made with it.

Professor F. B. Crocker said that, in this connection, it was interesting to recall the high-frequency machine built by Mr. Nikola Tesla, and which was demonstrated by him before the Institute.

WEDNESDAY'S SESSION.

The meeting on Wednesday morning was called to order with President Arnold in the chair, and a paper by Mr. H. H. Barnes, Jr., entitled "Notes on Flywheels," was read by the author. This paper will be found on another page of this issue. In it Mr. Barnes discusses the effect of the flywheel upon the parallel operation of alternators, and comes to the conclusion that the flywheel is impotent to ensure satisfactory synchronous operation, as distinct from the assistance given by the engine governor to the damping of the unit. Except for these two influences, the inherent tendency toward cumulative surging existing in the unit would predominate, and parallel running would be impossible. He advises that the use of lighter flywheels than is customary would be advisable. This greatly facilitates the adjustment of the engine governors, while it does not decrease the stability of the system.

Dr. W. S. Franklin, of Lehigh University, South Bethlehem, Pa., said that an inherent tendency to surge exists when the restituting force acting to prevent a change from the normal velocity is less than that which acts to prevent the return to the normal. This tendency to surging is independent of the period of the engine. Dr. Franklin thinks that the tendency to surging increases directly with the frequency, while the damping effect increases with the square of the frequency. He questioned whether the steadying effect mentioned by Mr. Barnes as being secured when the alternator exciters are coupled in parallel is due entirely to the loading of the leading machine. There might be alternating currents produced around the field coils, which would have some damping effect.

Professor Clarence Feldman, of Darmstadt, spoke of the success which had been obtained in Europe with gas engines coupled to light flywheels, when driving alternators with heavy damping. He thought that probably M. Leblanc had recognized the point made by Mr. Barnes, that the relative increase in electrical damping is more rapid than the corresponding increase in the inherent tendency to surge for a given decrease in weight of flywheel. It was worth noting that Leblanc's amortisseur had been tried first with a single-cylinder engine. Professor Feldman related some of his experiences with alternators in parallel. He has never used dampers, but has used steel pole-shoes. In one case there were machines of different sizes in the station. The larger machines operated excellently. The smaller machines could only be used for light loads, and could not be operated in parallel with the larger machines, as in this case they carried none of the load. In another case, four similar dynamos were driven by four similar engines. Three would operate perfectly in parallel, while the other showed a slight tendency to surge. The fault was traced to a defective dashpot.

Mr. Barnes, replying to Dr. Franklin, said that the damping secured by putting the exciters in parallel was not caused by any alternating currents set up, since drawing all the field current from one exciter did not give the desired effect. He had also tried cross-connecting the exciters, so that each machine drew its field current from the exciter upon another alternator; but this was not as satisfactory as paralleling the exciters. Mr. Barnes believes that the troubles that we have had in this country are due to local conditions. In Europe it is customary to use lighter flywheels and engines with three cranks. Over there electrical resonance is the chief difficulty encountered, while, as far as he knows, this trouble has been met in only one plant in America.

Dr. W. S. Franklin read his paper entitled "The Single-Phase Induction Motor." Dr. Franklin takes up this machine from a new point of view. He first assumes the secondary winding to be concentrated into two coils at right angles to each other. While these coils are in rotation, as regards flux, they may be considered as fixed in direction. The primary winding then sets up an alternating flux in a certain direction. One of these coils, having motion through its flux, has an electromotive force set up in it, which causes a current to flow, and this current sets up a flux at right angles to the primary flux. The second coil is threaded by the primary flux, and therefore has a current set up in it, due to transformer effect; but this coil is moving in the secondary flux, due to the current in the other coil, and there are hence two electromotive forces acting. The theory of the motor is worked out on this idea, and some fundamental equations deduced, which differ from those heretofore presented.

Dr. Franklin then discussed his paper, comparing it with the theory of the single-phase motor developed by Dr. C. P. Steinmetz. Dr. Steinmetz's theory is developed from a modification of the theory of polyphase motors. He approaches the subject by considering the methods of starting single-phase motors, and then modifies the theory to fit the running conditions.

A paper entitled "Wave-Form Variations of a Long-Distance Line," by Mr. George H. Rowe, of Boulder, Cal., was read by Mr. S. W. Ashe. This paper describes briefly the Standard Electric Company's system in California, and gave sets of oscillographs taken at various times of the day at several points on the line. These show considerable differences in the wave-form of the line current at these points. Some of the conclusions drawn from this study are as follows: the possibility of substituting induction motors for synchronous motors on lines that have a

large charging current. The charging current may differ from that calculated on the assumption of the sine law, and this assumption for long lines may lead to error. Variation in the wave-form is due partly to the distorting effect of the hysteresis loop under different conditions of load. It is impossible to design the machine to suit all wave-forms, and the variation in the amplitude factor in a long line may be considerable.

As there was no discussion on the last two papers, discussion of the papers read on the preceding day was reopened.

Dr. Franklin pointed out that there is no steady loss of voltage due to inductance, since this would mean a loss of energy. There is, however, an increase of resistance, due to inductance, since this causes uneven distribution of the current throughout the conductor.

Professor Feldman thought that Mr. Waters had underestimated the effect of the pole shape in his paper. In Europe this is thought to be an important factor. Determination of the reactance voltage is but a rule-of-thumb method, and good only for one type of machine. It was pointed out that the investigation now being made by Mr. Thorburn Reid had been carried out by Herr A. Arnold in 1898.

Mr. H. Ward Leonard took issue with the statement made in the papers of the previous day, that the success of the railway motor was due to its being a series machine. He had contended for fifteen years that a motor having a separately and constantly excited field was a better machine for railway work than the present series type. His ideas had recently been confirmed by his experience with an electric automobile. This had the usual equipment of two series motors. The series windings had been taken off and replaced with shunt windings. This gave the machine much better control, made it possible to balance it on any grade, to govern the speed at will, and had also reduced field losses from 1,100 watts to 120 watts. Mr. Leonard then spoke of the apparent success which had been secured with his electric railway system in recent private tests in Switzerland. The public tests were made the first part of this month, but the results have not yet been published. As is well known, these motors are separately excited.

Following the reading of the paper, luncheon was served, after which the members were conveyed by a special car to Columbia University, to inspect the library and the technical laboratories.

John W. Lieb, Jr.

John W. Lieb, Jr., president-elect of the American Institute of Electrical Engineers, was born in Newark, N. J., February 12, 1860. He attended the Newark Academy and Stevens High School in Hoboken, N. J., and was graduated with the degree of mechanical engineer from Stevens Institute of Technology in 1880, when he engaged as draughtsman with the Brush Electric Company, of Cleveland, Ohio. In 1881 Mr. Lieb entered the employ of the Edison Electric Light Company, New York city, as draughtsman. He was transferred to the experimental department at the Edison Machine Works in 1882. He assisted in the tests of the first "Jumbo" direct-connected Edison dynamos, and was put in charge of the in-

JOHN WILLIAM LIEB, JR., PRESIDENT-ELECT AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

stallation of the electrical equipment of the old Pearl street Edison station, under the direction of Mr. C. L. Clarke, chief engineer. Mr. Lieb assisted in the tests and experiments incident to the starting up of this pioneer station, and on the inauguration of regular service, September 4, 1882, under the auspices of the Edison Electric Illuminating Company of New York, was appointed its first electrician.

When a syndicate of Italian capitalists, with Professor Columbo as technical adviser, purchased a complete equipment of boilers, engines, dynamos and Edison underground system for Milan, Italy, Mr. Lieb was selected by Mr. Edison to direct the installation. The Milan station, equipped with Babcock & Wilcox boilers, six 150-horse-power Armington & Sims engines and Edison "Jumbo" dynamos, began regular service in 1883, and Mr. Lieb remained in charge as manager of the organization of the Italian Edison Company. He was appointed, in turn, its chief electrician, director of stations and chief engineer in general charge of the technical department of the company, which was engaged in manufacturing electrical apparatus, installing isolated plants and operating lighting and power stations throughout Italy. Mr. Lieb was one of the pioneers in the exploitation of the alternating-current system, beginning with the plant in Milan, Italy, in 1886, and using also the Thomson-Houston arc system extensively. He was also engaged in electric railroading, in connection with the trolley system of the city of Milan. In 1894 Mr. Lieb returned to the United States, and was appointed assistant to the first vice-president of the Edison Electric Illuminating Company of New York. From this position he advanced by steps to third vice-president and general manager. Upon the consolidation of various lighting interests in New York city, under the corporate name of the New York Edison Company, Mr. Lieb was appointed third vice-president and associate general manager, which position he now holds.

Mr. Lieb is also president of the Lamp Testing Bureau, a director in several electrical corporations, a member of the council of the American Society of Mechanical Engineers, member of the American Society of Civil Engineers, past-president of the Association of Edison Illuminating Companies and the New York Electrical Society, second vice-president of the National Electric Light Association, member of the Associazione Elettrotecnia Italiano, Franklin Institute, American Academy of Political Science and the Engineers' Club of New York city.

A Cableway Over the Andes.

A cableway, which, it is said, will be the longest in the world and will have the highest engine station yet existing, is to be installed on the Argentine side of the Andes by Adolf Bleichert & Company, of Leipsic. This cableway will extend from Chilectio station, on the Argentine Northern Railroad—which is 3,430 feet above sea-level—for a distance of twenty-two miles, to a point 14,933 feet above sea-level, or 1,300 feet higher than the summit of the Jungfrau. It will cross a chain of rocks and precipices, spanning, in some places, chasms nearly 300 feet wide and 600 feet deep, while at other points it will be supported by iron towers 130 feet high. All of the material will have to be taken to its destination on the backs of mules. The length of the cable rope will be eighty-seven miles. The line is intended to have a carrying capacity of forty-four tons of ore per hour, a carload of 1,100 pounds being despatched every forty-five seconds.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

High-Voltage Oil Switches.

The Stanley Electric Manufacturing Company, Pittsfield, Mass., has developed a line of high-voltage oil switches possessing a number of distinguishing features. These switches are so designed that the circuit is broken simultaneously at several points, distributing the resulting disturbance over a large area. For potentials above 6,600 volts, the various contacts are arranged in the same horizontal plane, so that the disturbances resulting from the rupturing of the arc are distributed over a wide area. The contacts are located comparatively near the surface of the oil, so that the gases—if there are any resulting from the explosion—are readily dissipated. By using comparatively large tanks and long breaks, the switch may be opened a number of times before the oil is appreciably carbonized.

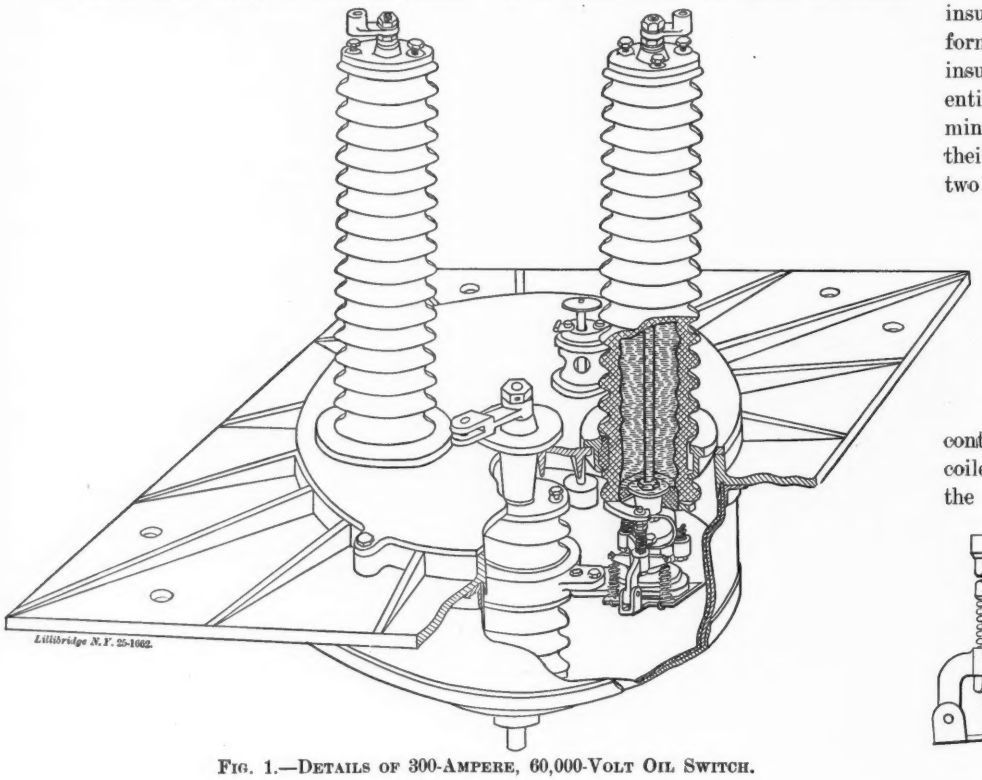


FIG. 1.—DETAILS OF 300-AMPERE, 60,000-VOLT OIL SWITCH.

These principles of construction are embodied in a new 300-ampere 60,000-volt oil switch which is shown in Fig. 1. A number of these have been installed as a part of the equipment of several high-voltage transmission systems in the West. Each pole consists of, first, a cast-iron top or mounting-plate, on which are located the two terminal contact insulators, a bearing of liberal length for the driving shaft, and a combined gas vent and automatic oil-level indicator; second, a tank filled with oil, in which are immersed the contacts, which are suitably insulated. The insulators are of porcelain, made in the form of corrugated cylinders. The centre insulator, carrying the contact blades, is entirely immersed in oil. The two terminal insulators are filled with, and have their lower ends immersed in, oil. These two insulators are held in position by means of hollow clamp rings, which are fastened to the insulator with set screws and cement. The contact blades are fastened to the central insulator in a similar fashion.

Fig. 2 shows the details of a contact. The contact arms are of hard-drawn flat copper strips. Each fixed contact is forced downward by three coiled springs, which are carried on the studs on which the fixed contacts slide, and which are screwed on the bottom of the insulator. These fixed contacts, as well as the blades, have finished surfaces. On closing the switch, each contact blade slides under the correspond-

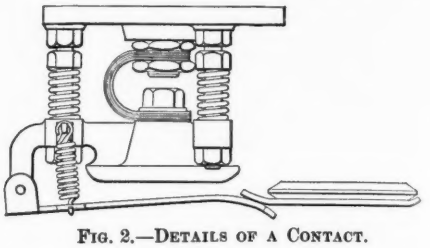


FIG. 2.—DETAILS OF A CONTACT.

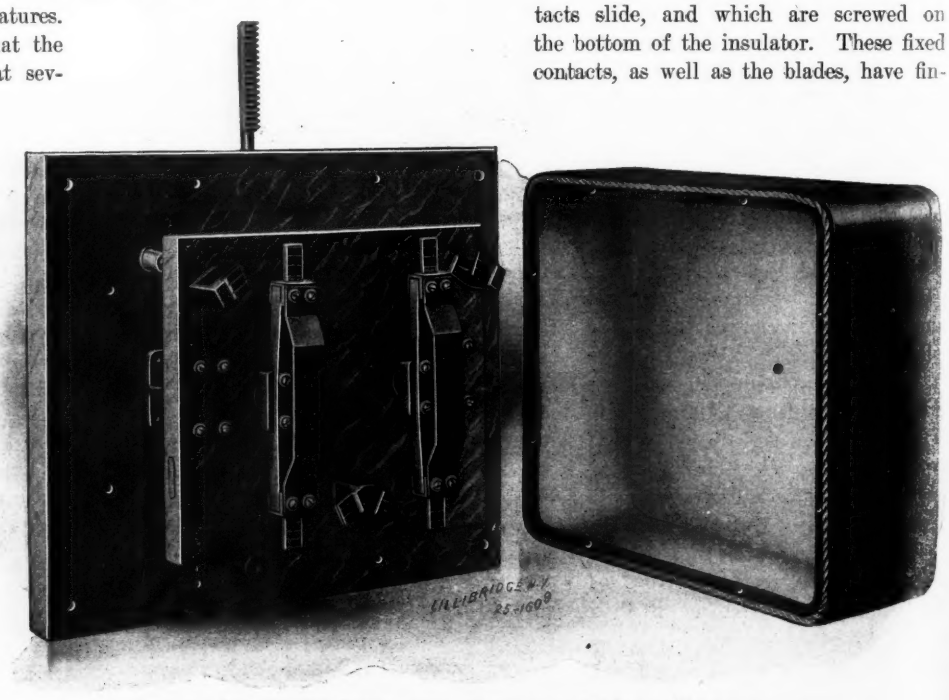


FIG. 3.—ONE OF THE POLES AND A TANK OF 15,000-VOLT OIL SWITCH.

ing fixed contact. The shape and position of the shunt or arc-rupturing contacts are such as to prevent any possibility of the arc being taken by the main contacts. These auxiliary contacts are readily replaceable.

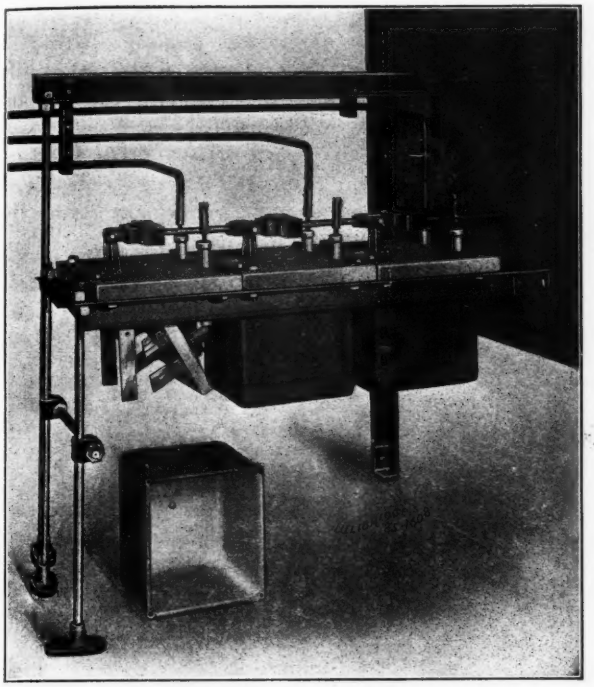


FIG. 4.—THREE-POLE OIL SWITCH FOR VOLTAGES UP TO 6,600 VOLTS.

In the illustration the oil-level indicator may be seen on the left of the insulator, the construction of which is exposed. Should the oil leak out, or for any other reason recede below a safe level, the indicator closes a pilot circuit, and warns the attendant by ringing a bell or lighting a lamp, as may be desired.

Each switch is tested at 120,000 volts, and, in installing, the iron top and tanks are grounded, making it safe for the operator to handle the controlling device.

The three-pole switch is made up of three of the units described above, connected by rods and a crank on each operating shaft to either a motor, magnet or hand-operated controlling device, and the operation of either of these devices may be controlled by plain overload, time delay overload or reverse current relays. Each pole of the switch may be mounted in either soapstone or brick compartment, or upon iron framework.

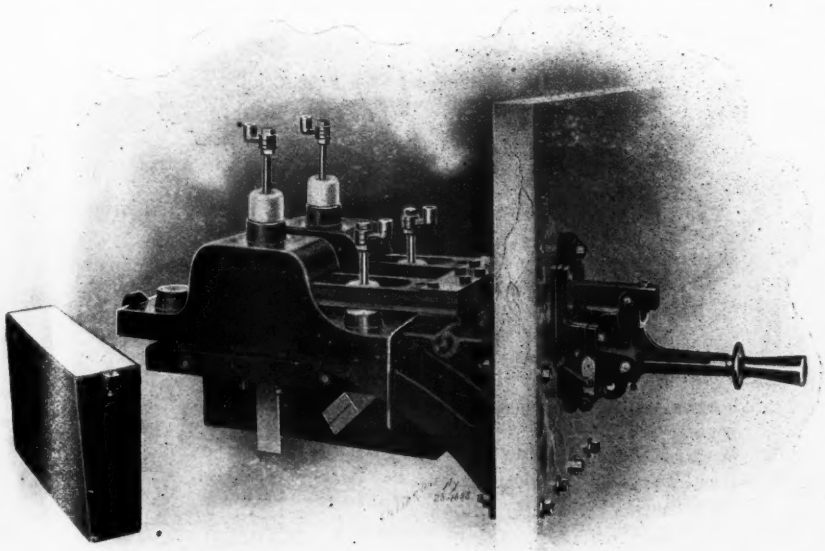


FIG. 5.—FOR INSTALLATIONS OF NOT OVER 3,500 VOLTS.

Fig. 3 shows one of the poles and the tank of a 15,000-volt switch. As the contacts are arranged in series, the circuit is broken simultaneously at four places. By connecting the two contact arms in parallel, the switch has twice the carrying capacity, with half the breaking distance, and becomes suitable for currents of 200 amperes at 7,500 volts. This type can also be used for seventy-five amperes at 20,000 volts, by changing the insulation carrying the leads.

This switch is also made double-throw, another set of contacts being placed diametrically opposite those shown in the illustration. The tanks may be mounted one above the other, or in tandem, as may be preferred.

Fig. 4 shows the three-pole oil switch for voltages up to 6,600 volts, and for currents up to 100 amperes. Each pole is in a separate oil tank. The tanks are mounted in a strong, light framework, consisting of angle-irons and rods. This switch is made with circuit-breaker attachment, if so desired, and either single or double-throw. One tank can be used for a double-throw switch with a capacity of 100 amperes at 2,400 volts, by connecting one blade to each pole. By connecting the blades in parallel, instead of in series, the switch may be used for 200 amperes at 4,000 volts.

Fig. 5 shows a type "E" oil switch, which is designed for installations of not over 3,500 volts. This is made either single or double-throw, and for any number of poles desired. The normal three-phase capacity of the switch is 400 kilowatts, and the emergency three-phase capacity is 1,200 kilowatts. This switch can be furnished with automatic overload opening device. When so furnished, the handle for closing the switch is not connected rigidly to the parts making contact, but is latched, the arrangement being such that it is impossible to close the switch when there is an overload or short-circuit on the line. When these switches are furnished with this overload feature, series transformers are also supplied, one being necessary for either a single-pole or two-pole switch, and two for either a three-pole or four-pole switch. There is a separate oil tank for each pole.

The Suburbanite.

The Suburbanite is a monthly magazine published by the passenger department of the Central Railroad of New Jersey, and is designed especially for those who are interested in suburban homes. The table of contents for May, 1904, includes "Golfing in the Suburbs," "Sewaren, a Suburb by the Sea," "How City Noises Affect the Health," "Lake Hopatcong as a Vacation and Excursion Resort," "Along the Jersey Coast," "The Cosy Corner and How t Make One," "Editorial Notes," etc.

New Type Machines of the New England Motor Company.

The accompanying illustration shows the multipolar generator and motor which is being placed on the market by the New England Motor Company, Lowell, Mass. This machine is built in sizes from 25 to 125 kilowatts in generators, and from 30 to 150 horse-power, in motors. They have the usual features of standard construction, including finely laminated armature cores, form-wound field and armature coils, and commutators of large surface. The construction is such as to ensure high efficiency and fine operating qualities, while the general appearance of the machine is workmanlike and symmetrical.

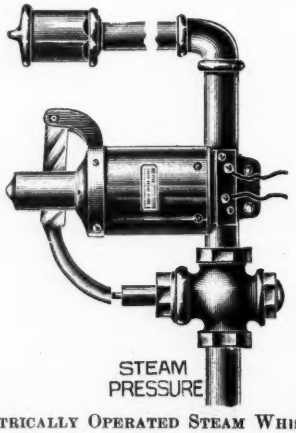
NEW TYPE MOTORS AND GENERATORS.

The De Forest Wireless Telegraph System.

The London *Daily Mail* for Saturday, April 30, devotes a full page to a description of the work of the De Forest wireless telegraph system in the Russo-Japanese war. The steamship Haimun is fitted with a De Forest installation, and this has been giving very valuable service to a London and a New York daily newspaper.

An Electrically Operated Air or Steam Whistle.

The Electrical Appliance Company, Cincinnati, Ohio, has developed a practical electrically operated whistle for signaling purposes. The accompanying illustrations show a standard type of whistle for all pressures of steam, and any voltage used, with alternating or direct current. The device operates any whistle three inches in diameter, at 150 pounds steam pressure, and when provided with a larger valve will operate a six-inch whistle at the same pressure. The whistle may be placed either indoors or out of doors and at any distance from the operating key. A feature of this whistle lies in its adaptability to use with alternating current. This is accomplished through the aid of the Churcher alternating rectifier.



ELECTRICALLY OPERATED STEAM WHISTLE.

This device, which is also manufactured by the Electrical Appliance Company, converts an alternating current into direct current of any required voltage and has a wide field of application.

Illuminating a Summer Amusement Resort.

What is probably the most extensive amusement resort ever conceived was opened at Coney Island, N. Y., Saturday evening, May 14. This large tract of land which has been converted into a miniature world's fair is called "Dreamland." The various amusement palaces have been constructed at a cost of over $3,500,000. The various towers and buildings are illuminated by 1,000,000 electric lights. A massive tower is erected, which is visible for a great distance. This tower rises to a height of 375 feet, being illuminated by 100,000 powerful electric lights.

Attachment Plugs.

The H. T. Paiste Company, Philadelphia, Pa., presents a strong line of attachment plugs for 1904. These are designated as "P-K," and cover both brass cap and porcelain types. The new "Push-in" style operates on an entirely new principle, as it is inserted and attached by simply pushing it into the socket, without twisting the cord. The two side springs, formed to fit an Edison screw shell, securely hold the plug in place, while a third spring at the end completes the circuit. This plug is shown in Fig. 1.

FIG. 1.—"PUSHIN" ATTACHMENT PLUG.

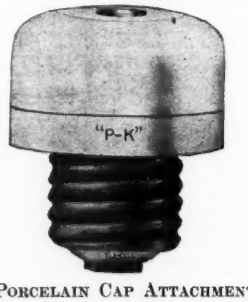


FIG. 2.—PORCELAIN CAP ATTACHMENT PLUG.

FIG. 3.—BRASS CAP ATTACHMENT PLUG.

The springs are all of special phosphor-bronze.

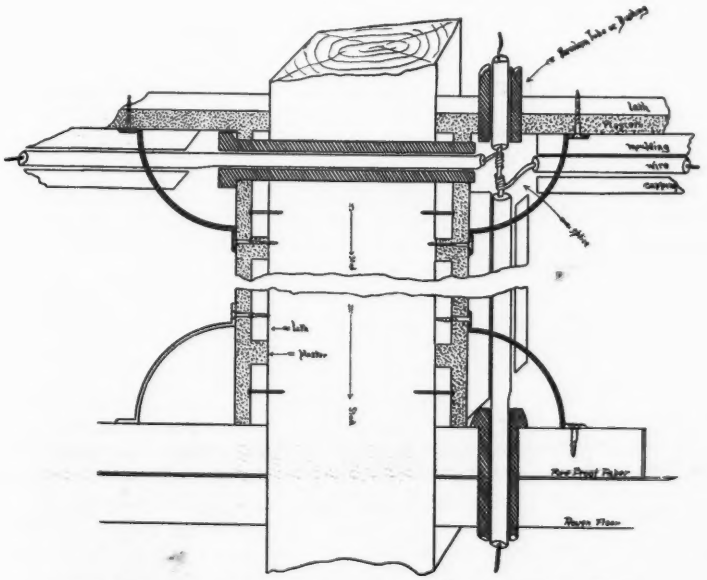
Fig. 2 shows a standard "P-K" attachment plug, which is made in Edison, Thomson-Houston and Westinghouse styles. The brass caps are fibre lined with fibre bushing already in place in the cord opening. These caps are securely held by their two set screws, which enter recesses in the porcelain base. (Fig. 3.)

All styles of "P-K" attachment plugs have cord openings at least thirteen-thirty-seconds of an inch in diameter, so that they are easily wired with reenforced show-window cord.

The Gleason Tube Protector.

The accompanying illustration shows the application of a new specialty invented by Mr. John L. Gleason, of 290 South street, Boston, Mass. This device is designed to protect insulating tubes from mechanical injury in passing through floors in connection with moulding work, and for furnishing area and concealment for splices made at junctions of ceilings and walls, where a mitred mould joint would not permit of splicing. This protector also conceals broken plaster or woodwork, caused by boring for insulating tubes through partitions or ceilings.

The protectors are made of iron, and are japanned for floor work. Where they are used on ceilings, they may be furnished in sheet metal to match the finish of the fixtures or installation hardware. The protectors are made in gangs of any number of strips or circuits, or singly, as desired. They are also made with opposite moulding recesses, to admit two mouldings at right angles to each other.



INSULATING TUBE PROTECTOR, FOR CEILING OR PARTITION WORK.

A Breakdown Test of the Nernst Lamp.

The Nernst Lamp Company, Pittsburg, Pa., has published a report of the results of a test made by the Philadelphia Electric Company in its laboratory, for the purpose of demonstrating the stability of the Nernst lamp. This report is dated January 27, 1904, and covers a test which was made on a six-glower 210-volt Nernst lamp. The lamp was supplied with new ballasts, heaters and glowers. The energy consumed by the heaters only, when the lamp was connected to a circuit of its normal rated voltage, was 280 watts. The voltage was increased in steps of ten volts, and the amount of energy consumed by the lamp at starting and after burning for five minutes was as follows:

Volts.	Watts at Start.	Watts at the End of Five Minutes.	Per Cent Increase.
210	582.4	588.0	....
220	649.6	630 9	4.7
230	683.2	652.4	9.5
240	728.0	694.4	14.3
250	784.0	767.2	19.0
260	896.0	896.0	23.8
266	994.0	....	26 6

After the voltage was increased to 240 volts, the ballasts showed signs of deterioration and started to blacken slightly. After the voltage was increased to 250, the centre ballasts were a deep black color, with a blue tinge. Upon increasing the voltage to 260, the ballasts were so hot that the glass bulged and the ballast wires were badly distorted. All of the ballasts were very black, but the glowers were in good condition. The wire in one ballast broke after being in circuit for four minutes. Another broke at the end of the fifth minute, and two more at the end of the sixth minute. The two outside ballasts broke at the end of eight and one-half minutes. When the eighth ballast broke, the heaters all cut in on one glower.

Further tests were made by burning the lamp at its normal rated voltage, and then subjecting it to an instantaneous increase in voltage, with the following results:

Condition No. 1—The lamp was supplied with new ballasts and started at 210 volts, and after the heaters were automaticlly cut out and the lamp burning under normal conditions, the voltage at the lamp terminals was increased instantaneously to 250 volts, or nineteen per cent increase. The ballasts showed no signs of deterioration.

Condition No. 2—The lamp was started at its normal voltage, and an instantaneous increase was made to 360 volts. The ballasts were then open-circuited.

Condition No. 3—The lamp was supplied with new ballasts only, and started at its normal voltage. The voltage at the terminals was increased instantaneously to 300 volts, and the ballasts showed no sign of deterioration.

Condition No. 4—The lamp was started at its normal voltage, and the voltage increased instantaneously to 315 volts. The ballasts showed no signs of deterioration.

Condition No. 5—The voltage was increased instantaneously to 325 volts, and the ballasts were all open-circuited.

Condition No. 6—The lamp was supplied with new glowers, heaters and ballasts, complete. It was started at its normal rated voltage, and the voltage at the terminals increased instantaneously to 325 volts. The result was the same as in condition No. 5.

Alternating-Current Apparatus to Be Given a Working Trial.

The General Electric Company is equipping the entire Ballston division of the Schenectady railway, Schenectady, N. Y., with an alternating-current equipment in order that a thorough service trial of a car equipped with alternating-current motors may be secured. The alternating-current equipment will be in addition to the present direct-current equipment which is the standard for operation of the Schenectady railway. It is thought that by placing a car in regular service that the real value of the alternating-current apparatus will be developed.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NIAGARA POWER BILL VETOED—Governor Odell announced on May 15 that he had vetoed the Thompson bill, extending the corporate life of the Niagara, Lockport & Ontario Power Company. The charter of the company expires this month. It is reported that as work was begun at Pendleton, N. Y., last month the original charter of the company will hold good.

SOUTH AFRICAN CENTRAL STATION—A company is being formed in Johannesburg, South Africa, for the purpose of erecting a central station to furnish power to the mines, and also to supply such demands for public lighting and power as are not met by the corporation's municipal plant. It is stated that Mr. James Swinburne, the well-known electrical engineer of London, has been engaged as consulting engineer.

NEW MISSOURI POWER CORPORATION—Papers of consolidation of the Sedalia Water and Light Company, the Sedalia Gas and Fuel Company, and the Electric Light and Power Company, have been filed at Sedalia, Mo. The capital of the company is $1,000,000. The corporation, which will be called the Sedalia Gas and Electric Company, will acquire, maintain and operate waterworks, gasworks, electric lighting and power works, a street railway and a system of power plants.

NEW POWER PLANT FOR RENO, NEV.—A new water and power company is to be established at Reno, Nev. Work on the new plant is expected to begin shortly, and the completion is looked for before the end of the summer. The company interested owns water rights on Hunter creek, five miles north of Reno, and will be in a position to supply 5,000,000 gallons of water per day for domestic purposes. It is stated that $2,000,000 will be expended in carrying out this work.

ELECTRIC LINE FROM INDIANAPOLIS TO CHICAGO—The Chicago & Northern Indiana Railroad Company, composed of Indianapolis capitalists, propose to build an electric line from Indianapolis to Chicago. Articles of incorporation have been filed with the secretary of state. The line will pass through the counties of Lake, Porter, Jasper, Pulaski, White, Cass, Howard, Clinton, Tipton, Hamilton and Marion. The new road will compete with all the steam roads running from Indianapolis to Chicago, and will carry both freight and passengers.

NEW POWER PLANT ON THE OHIO RIVER—It is announced that Isaac J. Miller, of Cincinnati, Ohio, has, after a careful investigation, completed data and plans for the construction of powerhouses on the Ohio river at different locations between Pittsburg and Cairo. The plan embraces the construction of a system of reservoirs at the head waters and different tributaries of the Ohio. An effort will be made to control the waters and maintain a nine-foot stage at all seasons of the year. The specification states that the system can be constructed at an outlay of $5,000,000.

A NEW TUNNEL BETWEEN NEW YORK CITY AND NEW JERSEY—The state board of railroad commissioners has granted a certificate to the Hudson & Manhattan Railroad Company to build two single-track tunnels under the Hudson river, between New York city, N. Y., and Jersey City, N. J. Mr. William C. McAdoo, president of the company, is also president of the New York & New Jersey Railroad Company, which has completed the old Hudson river tunnel connecting the two cities. The Hudson & Manhattan Railroad Company was incorporated in New York city on May 21, last year, and has a capital of $3,000,000.

MORE HYDROELECTRIC PLANTS FOR CALIFORNIA—Applications have been filed in the Stockton, Cal., United States land office for rights of way and sites for a number of large reservoirs and power plants in Fresno County, and for transmission lines from these power sites to Los Angeles, San Francisco, and from points in the San Joaquin valley, including Stockton. The main reservoirs, according to the application, will be in Crane valley in the Sierra Nevada mountains, in Fresno County. One of the reservoirs will contain 800 acres. It is said that the fall is so great there that the same water will be used in three power stations in a distance of eight miles. This application was made by D. L. Wishon, who is the reputed right-of-way agent for H. E. Huntington.

THE PORT CHESTER RAILROAD FILES PLANS AND SURFACE MAP TO SECURE ITS ROUTE—On May 6 the New York & Port Chester Railroad Company filed with the county clerk its plans for a twenty-five-mile four-track electric railroad from 136th street, New York city, to the state line, beyond Port Chester. This action of the company is regarded as proof that it is in shape to prosecute the work with vigor as soon as the board of aldermen and the board of estimate concede the desired permit. The plans cover every rod of the distance from 132d street and the Harlem river, where a connection is practicable with the subway system of the Interborough Rapid Transit Company, to the state line. The plans give the name of every property-holder and the expense of every holding traversed by the new road. The plans call for a route 100 feet in width. It is stated that the money is ready for the purchase of the right of way, which is to cost about $3,000,000, and for beginning construction work all along the line. It is estimated that the whole system will cost about $16,000,000.

PERSONAL MENTION.

MR. E. JONES has assumed the duties of manager of the Western Union Telegraph office at Sioux Falls, S. D. Mr. Jones succeeds J. C. Otterholm, who will go to St. Cloud, Minn., to engage in other business.

MR. JOSEPH H. THOMPSON, JR., announces that he has opened an office at 11 Broadway, New York city, for buying, exchanging and selling all kinds of new and second-hand electrical and steam machinery.

MR. J. W. STEED, who is connected with the International Steam Pump Company, is to have charge of the installation of the electrical equipment of the new Worthington works now being erected at Harrison, N. J.

DR. S. S. WHEELER returned last week from an extended tour in Europe, visiting London, Paris and Zurich. Dr. Wheeler and his wife spent a week automobiling through Brittany, and were delighted with the experience.

MR. R. G. BLACK, chief electrical engineer of the Toronto Electric Light Company, delivered an interesting address to the Canadian Association of Stationary Engineers recently, on "Alternating Current and How to Handle It."

MR. S. J. McMEEN, of Chicago, Ill., who is engaging in consulting engineering and patent law practice, as announced a short while ago, is now drawing up plans for an extensive telephone system to be installed in the City of Mexico, Mexico.

MR. R. E. HAMLIN has been made vice-president and general manager of the Toledo (Ohio) Home Telephone Company, and Mr. C. E. Stinson has been made assistant manager and superintendent of the electrical and structural department of the company.

MR. LOUIS F. PHILO, who for the past six years has been connected with the Wesco Supply Company, in the capacity of manager of the supply department, has resigned to accept the position of assistant manager of sales with the Ewing-Merkle Electric Company, of St. Louis.

MR. J. C. McQUISTON, until recently secretary, has been appointed superintendent of the Westinghouse Companies' Publishing Department, having charge of matters relating to the publicity of the products of the various Westinghouse interests in the United States and Canada.

MR. WILLIAM MARCONI arrived in New York Saturday morning, May 14. Special receiving apparatus had been installed on board of the vessel, the Cunard steamship Campania, and during his voyage Mr. Marconi was in touch with the Poldhu, Cornwall,

station for some 1,700 miles. As the instruments on board had not the same sending capacity, no messages were exchanged. Arrangements are being made to supply a daily ship news service, by receiving information from either side of the Atlantic within the 1,700-mile limit.

MR. ALFRED SLATER, formerly manager of the Wisconsin Telephone Company, at Janesville, and more recently in charge of the large independent company's plant at Rock Island, has taken charge of the offices of the Beloit Telephone Company, in place of J. E. Carr, resigned.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Boston, Mass., in the May issue of *Edison Light* publishes a reproduction of the celebrated Ives process print of a bust of Thomas Alva Edison. In addition to this there are a number of interesting sketches concerning Edison service in and around Boston, with numerous night scenes of incandescent lamp illumination.

MR. FRANK C. SMITH, of San Antonio, Tex., president of the Commercial Telephone Company, announces that he has purchased for his company the independent telephone exchanges at Austin, Taylor, Temple and Belton, and that he has leased from the Beaumont Northwestern Telephone Company the long-distance lines and local exchanges belonging to that corporation.

MR. HARRY J. CLARK has been appointed assistant to President and General Manager C. D. Beebe, of the Auburn & Syracuse Electric Railroad Company and the Rochester, Syracuse and Eastern Railroad. Mr. Clark was formerly chief engineer of the S. R. T. Company, and has recently been superintending the construction of the Mohawk Valley Railway and the Oneida Electric Railway.

MR. PAUL G. BURTON, who was connected with the Western Electric Company in the capacity of chief inspector of the telephone installation department, has been appointed superintendent of maintenance of the Chesapeake & Potomac Telephone Company. Before Mr. Burton left New York he was the guest of honor at a dinner given at the Arena by the Western Electric Foremen's Club, of which he was president.

MR. HERBERT H. VREELAND, president of the New York City Railway Company, has directed a letter to President Orr, of the rapid transit commission, suggesting a number of modifications in the plans for a second subway in New York city. Mr. Vreeland suggests that a crosstown loop under Chambers street is highly desirable, to secure good service, and that a connection with the proposed Jersey tunnel is also desirable.

MR. J. H. HALLBERG resigned his position a few weeks ago as general superintendent of the Cincinnati Gas and Electric Company, in order to engage as consulting expert in electrical distribution and illumination. Mr. Hallberg has opened a suite of offices at 45 Broadway, New York city. It is his intention to specialize in the above-named lines, and he will undoubtedly find a ready field for the application of his wide experience and knowledge.

MR. GEORGE C. EWING announces that tickets for the Pop concert to be held at Symphony Hall, Wednesday evening, May 25, in connection with the convention of the National Electric Light Association, will be in his hands for distribution to the delegates. There will be approximately 600 seats, at tables accommodating four or five each. These tickets are, of course, free to the delegates and visitors, and may be obtained by writing to Mr. Ewing at 501 Atlantic avenue, Boston, Mass., or secured from him personally on arrival in Boston.

"FRANK B. COOK, 240 West Lake street, Chicago, Ill., now has an exclusive license to manufacture and sell all self-soldering heat-coils and other circuit-protecting devices and apparatus covered by patents and application for patents, as well as any devices of that kind which may hereafter be invented by Charles A. Rolfe, or owned and controlled by the Rolfe Electric Company." This announcement is made by Charles A. Rolfe, president of the Rolfe Electric Company.

PROFESSOR ALBERT W. SMITH, head of the college of mechanical engineering in Leland Stanford, Jr., University, California, was elected, at a recent meeting of the board of trustees of Cornell University, to succeed the late Professor R. H. Thurston as director of Sibley college of mechanical engineering. Professor Smith is a Cornell graduate, class of 1878, and from 1887 to 1891 he served on the Sibley college faculty as assistant professor of mechanical engineering. He next went to the University of Wisconsin, where he was professor of machine design. From there he was called to California.

MR. CHARLES SUMNER HOWE was installed as president of the Case School of Applied Science, Cleveland, Ohio, recently, in the presence of many distinguished educators, representing nearly all the prominent institutions of learning in this country. President Henry Churchill King, of Oberlin College, delivered the invocation. Worcester Reed Warner made an address on behalf of the trustees, to which President Howe responded. President Ira Remsen, of Johns Hopkins University, spoke in behalf of the universities, and President Henry Smith Pritchett, of the Massachusetts Institute of Technology, on behalf of the technical schools. John R. Freeman, of the American Society of Mechanical Engineers, made an address on behalf of the technical societies, and President Charles Franklin Thwing, of Western Reserve University, on behalf of the colleges of Ohio. Mr. Howe then delivered his inaugural address.

MR. JOHN FINDLEY WALLACE, M. Am. Soc. C. E., general manager of the Illinois Central Railway Company, has accepted the appointment of chief engineer of the Panama Canal, at a salary of $25,000 per year. Mr. Wallace was born at Fall River, Mass., September 10, 1852. He was educated at Monmouth College, Monmouth, Ill., and in 1869 he commenced civil engineering as a rodman on the Carthage & Quincy Railroad. In 1871 he was appointed a rodman in the United States Engineer Corps, at Rock Island, Ill., and later made United States assistant engineer under Colonel M. Macomb. In 1876 he engaged in private practice, and in 1879 was appointed chief engineer of the Burlington, Monmouth & Missouri River Railroad. In 1887 he was made resident bridge engineer of the Atchison, Topeka & Santa Fe Railroad. In 1889 he was associated in private practice with Mr. E. L. Corthell. In 1891 he was appointed engineer of construction of the Illinois Central Railroad, and in 1892 was made chief engineer of the system. In 1897 he resigned that position, but returned to the company again in 1898 as second vice-president, having control of all of the physical conditions of all engineering work on that system. In 1902 he was made general manager of the company, which position he held until his appointment as chief engineer of the Panama Canal.

LEGAL NOTE.

MEASURING INSTRUMENT LITIGATION—On May 9, in the United States Circuit Court for the Southern District of New York, Judge Lacombe filed an opinion, declining to grant an injunction against the Whitney Electrical Instrument Company and Machado & Roller, upon the Weston patent No. 392,387.

OBITUARY NOTICES.

MR. CHARLES W. GRANT, a well-known business man of upper New York, died at Jamestown, N. Y., May 10, at the age of sixty years. Mr. Grant was one of the organizers and for many years president of the Jamestown Electric Light and Power Company, from which he retired several years ago.

GENERAL ANDREW HICKENLOOPER, one of the well-known central station men of this country, died at Cincinnati on May 12. He was a civil engineer in Cincinnati, for the past thirty years was president of the Cincinnati Gas and Electric Company, and was a famous commander during the Civil War in the Union Army, rising rapidly from captain to brigadier-general. He was lieutenant-governor of Ohio from 1880 to 1882. At the time of his death General Hickenlooper was sixty-seven years old.

MR. NELSON PERIN, one of the leading financiers of Baltimore, Md., died, after a long illness, at Baltimore on May 12. Mr. Perin was one of the pioneers of rapid transit in Baltimore and was the first president of the United Railway and Electric Company. He retired from the presidency of the company three years ago. Mr. Perin was also the promoter of the present electric lighting system of Baltimore, and was chiefly instrumental in the erection of the well-known Belvidere Hotel of Baltimore. At the time of his death he was fifty-one years of age.

TELEPHONE AND TELEGRAPH.

MORGANTOWN, PA.—The telephone line between this place and Joanna is being rebuilt.

BALTIMORE, MD.—A telephone line will be built between Charlotte Hall and Mechanicsville.

LAUREL, MISS.—The city council has granted the Cumberland Telephone Company a franchise for twenty-five years.

WINONA, OHIO—The Winona Central Telephone Company has begun the extension of its system to the village of Dungannon.

SALT LAKE CITY, UTAH—The construction of the Western Union telegraph line from Calientes toward Los Angeles has been begun.

CONNELLSVILLE, PA.—The Tri-State Telephone Company announces the completion of its lines between Fayette County and Pittsburg.

TRENTON, N. J.—The Delaware & Atlantic Telephone Company has bought out the Hopewell Telephone Company, and will modernize the Hopewell plant.

MINNEAPOLIS, MINN.—A franchise to extend telephone lines into White Bear Lake has been granted by the village council to the Twin City Telephone Company.

SWEDESBORO, N. J.—The People's Rural Telephone Company will erect lines connecting Swedesboro with Mickleton, Repaupo, Bridgeport, Mullica Hill and Harrisonville.

TROY, N. Y.—The Cooperstown, Cherry Valley & Sharon Springs Telephone Company has certified to the secretary of state that it has increased its capital stock from $5,000 to $10,000.

PAPILLION, NEB.—The Mutual Telephone Company, which was recently organized among the farmers of the western part of Sarpy County, has begun the work of construction. A franchise has been secured permitting it to enter Louisville.

BENTLEYVILLE, PA.—A local telephone company that will furnish service between this place, Ellsworth and Garwood has been organized with the following officers: president, A. N. Booth; secretary, William Greenlee; treasurer, C. K. Frye.

NORFOLK, VA.—James P. Copeland has completed a wireless telegraph station at Cape Hatteras, and will organize a stock company to operate wireless stations at Newbern, Hatteras, Roanoke Island and Norfolk. The Fessenden system is to be used.

MIDDLEBURG, PA.—The Snyder County Rural Telephone Company has been organized by the election of G. Alfred Schoch, as president, and J. M. Baker, secretary. This company is organized to take the place of the United Telegraph and Telephone Company.

DOUGLAS, WYO.—A telephone line from Lost Springs to Orin, a distance of eight miles, will be constructed by A. A. Spaugh. From Orin the Bell company will extend the line to Douglas, giving subscribers connection with Manville, Lusk and intermediate points.

GALVA, ILL.—The Galva Telephone Company has completed connection with Kewanee, giving its subscribers service with Neponset, Buda, Wyanet, Tiskilwa, Princeton and other points. A through line is now contemplated from Galesburg to Princeton, with Galva connections.

FREEWATER, ORE.—A farmers' telephone company has been organized for the purpose of constructing a telephone line between here and Walla Walla. The installation of this system will give telephone communication with most of the thickly settled country north of Freewater.

OLATHE, KAN.—Oscar Ayres, of Gardner, has purchased the Olathe Citizens' Telephone Company for $20,000. The sale includes the lines to Stanley, Gardner, Bonita and all other lines in the county. Connection is to be made with the Home Telephone Company, of Kansas City.

GRANITEVILLE, S. C.—A local telephone company has been organized in this town with the following officers: W. A. Giles, president and treasurer; Graves L. Knight, T. H. Rennie and W. A. Giles, directors. Long-distance connection with the Southern Bell Telephone and Telegraph Company will be arranged for.

TERRE HAUTE, IND.—At a meeting of the stockholders of the Citizens' Telephone Company it was decided to put in 32,000 feet of new cable, in order to meet the increase of business. Two sections will be added to the main switchboard at the central exchange, and another section will be added to the board at the north exchange. The cost of these improvements will be $26,000.

BATAVIA, N. Y.—Stockholders of the East Pembroke Telephone Company have decided to unite with the Darien Telephone Company, and connections will be made as soon as the lines can be built in East Pembroke and vicinity. This will connect the East Pembroke subscribers with the Bell Telephone Company, as the Darien company has a contract with that company.

ST. PAUL, MINN.—The Renville Rural Telephone Company, with a capital of $20,000, has filed articles of incorporation, and will install a telephone system connecting Fairfax, Franklin, Morton, Renville, Olivia, Bird Island, Hector and Buffalo Lake. The incorporators are A. E. Carver, A. E. Rieke, S. W. Smith, Paul Albrecht and C. W. Parsons, of Fairfax, and O. W. Harris and R. E. O'Keefe, of Franklin.

WARSAW, N. Y.—At the annual meeting of the Wyoming County Telephone Company it was announced that a contract had been made whereby the company secures all the telephones of the Bell Telephone Company in the towns of Castile, Pike and Gainesville. The purpose is to rebuild the lines of the Wyoming County company and install a central station at Castile, giving long-distance connection with the Bell company's lines to all sections.

GREELEY, COL.—The annual meeting of the stockholders of the Morgan County Independent Telephone Company was held in Greeley recently and the following officers and directors were elected for the ensuing year: W. H. Clatworthy, Fort Morgan, president and director; C. C. Townsend, Greeley, vice-president and director; R. M. Handy, Fort Morgan, secretary and director; L. C. Stevenson, Fort Morgan, general manager; Arthur Hotchkiss, Fort Morgan, treasurer.

TAYLORSVILLE, LA.—A number of citizens, representing this town, Bezer, Raleigh and Mize, have organized a stock company for the purpose of building a telephone line connecting the four points named. A line is being built from Forest, on the Alabama and Vicksburg road, to Raleigh, so that when the two lines are completed to the latter town, connection will be established between Forest and Taylorsville and at least a dozen of the most important points in Smith and Scott counties.

ALTOONA, PA.—The Highland Telephone Company has been formed to establish a line in Summerhill and Cambria townships, Cambria County. The line will start at Wilmore and take in an area of from ten to twelve miles. It will cost, it is said, from $50 to $60 a mile. The subscribers or members of the company will rent or buy outright their instruments. The company has organized by the election of the following officers: president, Lincoln Roberts; vice-president, Lemuel J. Hughes; secretary, Daniel W. Jones; treasurer, Robert S. Roberts.

WASHINGTON, D. C.—The larger towns in the lower end of St. Mary's County, Md., are to be connected by telephone. At the last session of the Maryland legislature the Southern Maryland Telephone Company was chartered and has organized for business. Mechanicsville and Charlotte Hall have been connected by a double metallic circuit, and the line is to be extended to Leonardtown, Brandywine and other points in the county. The officers of the new company are: J. T. Coad, president; L. J. Canter, vice-president; J. B. Ballinger, secretary and treasurer; J. L. Sothoron, recording secretary, and George M. Thomas and Dr. Z. R. Morgan, directors.

SCHENECTADY, N. Y.—The annual meeting of the Schenectady Home Telephone Company was held in this city on May 5. The reports presented by the officers show that this company is doing a most satisfactory business. During the year the number of subscribers has increased nearly 100 per cent. The following officers and directors for the ensuing year were elected: Charles F. Veeder, president; I. H. Griswold, vice-president; S. M. Strong, secretary; Evans S. Kellogg, treasurer. Directors, Charles F. Veeder, Evans S. Kellogg, H. C. Hequembourg, James M. McNaughton, James M. Andrews, H. E. Webster, Charles E. Palmer, A. J. Quackenbush, Schenectady; Howard Hendrickson, Albany; S. B. Rawson, T. M. Brush, E. E. Williams, F. H. Sudro, I. H. Griswold, Elyria, Ohio; J. F. Deems, New York.

ELECTRIC RAILWAYS.

HARRISBURG, PA.—The Valley Traction Company has bought the Baltimore, Westminster & Gettysburg Electric Railway Company.

NIAGARA FALLS, N. Y.—The Toronto Street Railway Company is erecting a $70,000 transformer station for the handling of power from Niagara Falls.

CLEARFIELD, PA.—The Clearfield & Curwensville Street Railway Company, recently incorporated, has asked the boroughs of Clearfield and Curwensville for franchises. The street car line will be twelve miles in length and will connect the two towns.

LEWES, DEL.—The survey for the Lewes-Rehoboth trolley road has been completed, and B. F. Sweeten, president of the company, has announced that the survey for the line from Lewes to Seaford, across Sussex County, by way of Midway, Angola and Georgetown, will be pushed rapidly.

SAN FRANCISCO, CAL.—Plans have been formed for the construction of the Ventura & Ojal Valley Electric Railway, which is intended to operate between the towns of Ventura County, Cal., as a pony freight. Negotiations for the purchase of the Ventura street railway system are pending.

LANCASTER, PA.—Work will shortly commence on a trolley line that will ultimately connect this city and Oxford. The new road will start at Martic Forge, where it will connect with the Lancaster & York Furnace electric road, and run to Westbrook Station, on the Lancaster, Oxford & Southern steam road.

EASTON, PA.—The Easton Consolidated Electric Company has resumed control of its lines, operating under the title of Easton Transit and the Easton, Palmer & Bethlehem, including the line to South Bethlehem, by way of Freemansburg, and the line to Nazareth. These lines were for several years operated by the Lehigh Valley Traction Company under a lease.

RENO, NEV.—At a meeting of the city council S. N. Griffiths, who, with H. E. Huntington and others of California, is the principal owner of the Washoe County Traction Company, announced that he and his associates will build an electric road from this city to Lake Tahoe. Abundance of power to operate the road will be generated by the Truckee river. The proposed line will be forty miles in length.

WICHITA, KAN.—O. A. Boyle, president of the Arkansas Valley Interurban Railway Company states that grading work on the new line will begin as soon as possible. The road will cost about one and one-half million dollars, and will connect Wichita, Belle Plaine, Wellington, Gueda Springs and Arkansas City. It is the intention, eventually, to tap the coal fields of Oklahoma and Indian Territory. Freight and passenger traffic will be solicited.

NEW LONDON, CT.—The charter of the East Lyme Street Railway Company has been formally transferred to a New York syndicate composed of A. F. Phelps, J. A. Morgan and C. C. Phelps. The company, which has an authorized capital stock of $150,000, has a valuable charter and is authorized to build a street railway running from New London through Waterford to East Lyme, a distance of about eleven miles. The new owners will organize and then will immediately proceed to perfect surveys. The work of construction will be pressed forward as rapidly as possible, and the company expects to have the road in operation by the end of August.

UNION, S. C.—Announcement is made that Mr. T. C. Duncan will soon begin building an electric line between Roebuck, on the Atlantic Coast Line, to a point on the Georgia Central & Northern Railroad, *via* Neal Shoals. This line will be an extension of the present road from Union and Buffalo. It will pass through the town of Union, going southeast by Neal Shoals to some point in Chester County and connect with the Georgia Central & Northern Railroad on the northwestern side. It will probably touch Glenn Springs on its way to Roebuck. The motive energy will be furnished by the electric power-house now being built at Neal Shoals, in this county, where the falls of Broad river provide something like one hundred and fifty thousand horse-power. This trolley line will handle freight as well as passengers. By connecting with the two large railroad systems it will give a much needed opening for passenger and freight traffic.

ELECTRICAL SECURITIES.

There was a slight improvement in activity at the close of last week. The long-standing apathy which has characterized the market, now that it has extended well into the month of May, is claimed, in many quarters, to be an indication that there will be but a slight change throughout the summer. While this may be the case, there also appears to be a marked confidence in the ability of the market to withstand any serious onslaught by the bear party. The large gold shipments in connection with the Panama Canal payments have been made with comparatively little effort and with apparently no after-result upon either the interior or local banks. Railroad earnings have shown further decreases, and it is possible that the lateness of the agricultural crop in general will lend aid to the pessimistic in assuming the outlook to be a gloomy one. However, there are those who are assuming that the lull which has taken place during the last six months has afforded ample opportunity for rest from the vigorous business campaigns of the last two years, and that, with the consummation of the national election, there will come about a renewed interest throughout the country.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MAY 14.

New York:	*Closing.*
Brooklyn Rapid Transit	45⅝
Consolidated Gas	209½
General Electric	155½
Kings County Electric	183
Manhattan Elevated	142½
Metropolitan Street Railway	110⅝
New York & New Jersey Telephone	143
Westinghouse Manufacturing Company	175

Directors of the Kings County Electric Light and Power Company have declared the regular quarterly dividend of 2 per cent, payable June 1. Books will remain closed from May 21 to June 1.

At the annual meeting of the Schenectady Railway Company, held at Schenectady, N. Y., May 10, the old board of directors was reelected. About seventy per cent of the stock was voted, the largest amount in years. After the annual meeting a special one was held and the proposition to increase the capital stock by the amount of $3,325,500 was adopted. The present capital stock is $45,000,000.

The annual meeting of the Interborough Rapid Transit Company was held in New York city on May 11. The only business transacted was the reelection of the four directors whose terms expired on that day, namely, Gardner M. Lane, John Pierce, Alfred Skitt and George W. Young. At the next regular meeting of the directors the officers will be reelected. For the quarter ended March 31, the gross earnings of the company were $3,845,121, and the expenses, $1,609,823, leaving net of $2,235,298; other income, $93,850, a total of $2,329,148; charges, $2,127,156, leaving a surplus of $202,012, as compared with $166,461 for the same period of the preceding year. For the nine months, July 1 to March 31, the statement is as follows: gross, $10,441,583; expenses and taxes, $4,313,839, leaving net of $6,127,744; other income, 259,736, making a total of $6,387,480; charges (including dividends on Manhattan Railway Company), $5,220,190, leaving a surplus of $1,167,290, compared with $180,222 for the corresponding period of last year. The general balance-sheet of the Manhattan Railway Company (operated by the Interborough company) as of March 31, 1904, shows total assets of $104,609,788, and liabilities of $97,503,289, leaving a surplus of $7,106,499.

Boston:	*Closing.*
American Telephone and Telegraph	126
Edison Electric Illuminating	235
Massachusetts Electric	69½
New England Telephone	123
Western Telephone and Telegraph preferred	77

Philadelphia:	*Closing.*
Electric Company of America	8
Electric Storage Battery common	56½
Electric Storage Battery preferred	56½
Philadelphia Electric	5 7-16
Union Traction	49⅞
United Gas Improvement	82½

Chicago:	*Closing.*
Chicago Telephone	112
Chicago Edison Light	144
Metropolitan Elevated preferred	45½
National Carbon common	28½
National Carbon preferred	101¾
Union Traction common	5½
Union Traction preferred	29

Metropolitan Elevated directors have reelected officers. It is stated that recent earnings of the company have been at the rate of 4½ per cent on the preferred stock.

ELECTRIC LIGHTING.

WRENTHAM, MASS.—E. P. BENNETT is about to install a plant to furnish electric lights to this town.

TERRE HAUTE, IND.—Work has been started on the new power-house of the Terre Haute Electric Company.

MILLTOWN, N. J.—The borough council has awarded a contract for street lighting to the Public Service Corporation.

MANCHESTER, IOWA—A move is on foot to organize a stock company for the purpose of establishing and operating an electric light plant in Coggon.

BARTLETT, TEX.—St. Louis capitalists are said to be negotiating with business men at Bartlett, Granger and Holland for installing an electric light plant at these three places.

JOHNSTOWN, PA.—The Pennsylvania Railroad Company has begun the erection at Washington of an electrical power plant to supply the light for passenger cars on the Chartiers Valley road.

BAY CITY, MICH.—The report of the superintendent of the city electric light station shows that it costs the city $69.40 per year for each arc light, with an average run of about eight hours per day.

DULUTH, MINN.—A franchise for the lighting of Chisholm's streets and the operation of an electric light plant has been awarded by the village council to the Crowley Electric Company, of Duluth.

SPRINGFIELD, ILL.—The Carthage Electric Light and Heating Company has increased its capital stock from $20,000 to $50,000, and changed its name to the Carthage Electric Light and Power Company.

MANITOWOC, WIS.—William Rahr, Olga Rahr and William Rahr, Jr., have organized the West Side Electric Power and Light Company with a capital of $25,000. A modern electric lighting plant will be built.

PITTSFIELD, ME.—Fire recently destroyed the plant of the Pittsfield Electric Light and Power Company, entailing a loss of $50,000, partly covered by insurance. The company furnished the town with street lights.

EAU CLAIRE, WIS.—All the property, including the franchise, of the Eau Claire Light and Power Company has been conveyed to the Chippewa Valley Electric Railroad Company, of which Arthur E. Appleyard is president.

MOBERLY, MO.—At a special election, a franchise was granted to the Moberly Light, Heat and Fuel Company for an electric, gas light, power and fuel plant. The company was also awarded a ten-year contract for street lighting.

REDLANDS, CAL.—The Mentone Power Company, which is owned by the Huntington interests, will shortly have its large power-house in the Santa Ana Cañon ready for operation. This station is expected to develop 2,500 horse-power.

SAN FRANCISCO, CAL.—The Mutual Electric Light Company has called a meeting of the stockholders for June 21 to vote an issue of $400,000 five per cent thirty-year gold bonds for extension. The company is erecting a 5,000 horse-power plant.

BURLINGTON, VT.—A contract has been let for the building of a large dam at the outlet of Howe's pond, in Readsboro. The dam will create an immense water power that will be used to furnish electric lights and power for the towns and cities in the Deerfield valley.

ELKHART, IND.—The city council has given the Elkhart Power Company a perpetual franchise for an electric heat, light and power system, and also a contract for street lighting, to begin August 1, 1904, when the contract with the Elkhart Electric Company will expire.

BROOKLYN, N. Y.—The Huntington Light and Power Company has a contract to furnish the Huntington Railroad, a branch of the Long Island Railroad, with power to operate its cars, beginning May 15. The power company will double the capacity of its plant in order to take care of this service.

NEW ORLEANS, LA.—Mr. Jules Dreyfus, president of the Consumers' Electric Company, announces that $1,000,000 will be spent upon the company's plant. Contracts will be let at once, and it is expected to have the plant in operation by September 1. Its capacity will, it is stated, be sufficient to supply almost the entire city.

BANGOR, PA.—At a meeting of the stockholders of the Bangor Electric Light, Heat and Power Company the following board of directors was elected: Milford Bray, Dr. D. H. Keller, Dr. F. B. Dilliard, George Mutton, John I. Miller and Oliver Labar. The following officers were also elected: William Bray, president; Davis Hambright, secretary and superintendent, and Milford Bray, treasurer.

WALLA WALLA, WASH.—A mortgage for $250,000 on the personal property, rights of way, water right on the south fork of the Walla Walla river in Umatilla County, and on the electric light plants of the Washington & Oregon Power Company has been filed. The money is to be used in constructing a large power plant on the Walla Walla, to supply Walla Walla, Pendleton and intervening towns.

DANIELSON, CT.—Enlargements which will more than double the capacity of the plant of the People's Light and Power Company are now being made. Two new dynamos, having a capacity of 3,000 lights each, and also an additional boiler, are being installed, and a stack 100 feet high will be erected. The company has a force of men at work extending its line to Moosup, whence it will be continued to the villages of Wauregan and Central Village.

GOUVERNEUR, N. Y.—At a special meeting of the village trustees, J. H. Abbott accepted the electric light, heat and power franchise and signed a contract to furnish light for forty-nine or more arc lamps at $65 per lamp per annum for a period of four years from April 1 next, with the privilege of renewing the contract for a term of five years at the same price. The franchise will be forfeited if the plant is not ready to operate by April 1, 1905.

GRANITE FALLS, MINN.—A company has been organized and incorporated for the purpose of improving the Minnesota Falls water power. The incorporators are E. H. Sorlien, H. H. Sorlien and Olaus Lende, of Granite Falls, and Lydon A. Smith and E. A. Aspnes, of Montevideo. E. H. and H. H. Sorlien own the land on both sides of the river, several hundred acres on the west side and about ten acres on the east side of the falls. The main object of the company is the transmission of power from the falls to Montevideo for lighting and power purposes, a distance of about seventeen miles.

SPOKANE, WASH.—Thomas L. Greenough has closed a contract with the Washington Power Company for 500 horse-power, to operate all the machinery of the Morning mine, three and a half miles above Wallace, Ida., on the Cœur d'Alene river, at the mouth of Grouse gulch. The power will be used in the compressor plants to compress air which will be used to run the drills, the hoists and all the other apparatus. A substation will be built at Grouse gulch, and will be in operation by September 1, when the contract goes into effect. The Washington Water Power Company has contracts for a minimum of 1,800 horse-power a year among the mines of the Cœur d'Alenes. From the Spokane falls it is operating the machinery of the Standard, the Hecla, the Mammoth, the Bunker Hill and Sullivan and the Last Chance, besides several smaller mines.

PITTSBURG, PA.—Plans are being completed by independent companies to erect modern plants and secure contracts for furnishing light to the various boroughs and other consumers in nearly every borough from Wilkinsburg to the county lines east, south and north. The Wilmerding Electric Light Company has made application at Harrisburg for a merger of the charters of the Wilmerding Electric Company, People's Light Company, of East McKeesport, Citizens' Electric Light Company, of North Versailles township, and the Patton Electric Light Company, to furnish light in Patton township. After the merger is completed an effort will be made to secure contracts in all the territory in which franchises have been granted. The company is capitalized at $50,000. The Keystone Electric Light Company, of Braddock, has franchises to erect poles and wires in Braddock and Rankin, and will ask for rights through North Braddock and East Pittsburg. The company has a capital of $50,000. The Mifflin Light and Power Company and the Homestead Light and Power Company, Hays Light and Power Company, West Homestead Light and Power Company, Munhall Light and Power Company are all owned by Homestead men. Charters have been granted and a number of franchises awarded them.

AUTOMOBILE NOTE.

SERVICE TEST OF MOTOR WAGONS—The Automobile Club of America has announced the following official awards for efficiency in the recent commercial vehicle contest which was held from April 4 to April 9, in New York city: First class, to carry 1,000 pounds or under—Olds Motor Works, gasoline delivery wagon, gold medal; Olds Motor Works, gasoline delivery wagon, silver medal; Knox Automobile Company, gasoline delivery wagon, bronze medal. Second class A, to carry 1,000 to 2,000 pounds—Pope Motor Car Company, electric delivery wagon, gold medal; Knox Automobile Company, gasoline delivery wagon, silver medal; Pope Motor Car Company, electric delivery wagon, bronze medal. Second class B, to carry 1,000 to 2,000 pounds—Cantono Electric Tractor Company, electric delivery wagon, gold medal; Electric Vehicle Company, electric delivery wagon, silver medal; Rockliff, gasoline delivery wagon, bronze medal. Third class, to carry 2,000 to 3,000 pounds—Consolidated Motor Company, gasoline delivery wagon, gold medal; Knox Automobile Company, gasoline delivery wagon, silver medal. Fourth class, to carry 3,000 to 4,000 pounds—Union Motor Truck Company, gasoline stake truck, gold medal. Fifth class, to carry 4,000 to 5,000 pounds—Electric Vehicle Company, electric truck, gold medal. Eighth class, to carry 8,000 to 10,000 pounds—Fischer Motor Vehicle Company, gasoline-electric truck, gold medal.

INDUSTRIAL ITEMS.

THE HAZARD MANUFACTURING COMPANY, Wilkesbarre, Pa., has recently opened up its own warehouse and office, at 71 and 73 West Adams street, Chicago, Ill.

THE WARREN ELECTRIC AND SPECIALTY COMPANY, Warren, Ohio, is distributing a leaflet which contains a short sermon in connection with "Peerless" lamps. Leaflet will be sent on request.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is issuing the May, 1904, copy of "The Emerson Monthly," together with a pocket map of the St. Louis World's Fair and of the city of St. Louis. Publication and pocket map will be sent on request.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., reprints a timely article on the installation of chloride accumulators in small central stations by W. J. S. Waring. This matter is contained in bulletin No. 82, which will be sent to interested parties upon request.

THE SPRAGUE ELECTRIC COMPANY, New York city, will be pleased to send its 1904 catalogue, descriptive of "Lundell" electric fans. These fans are made in twelve and sixteen-inch swivel and trunnion desk types, ceiling fans and exhaust fans. They are finished both in black japan and ornamental brass.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., will be pleased to send circulars describing field rheostats, motor speed controllers, theatre dimmers, resistance units, circuit-breakers, navy panels and other types of motor starters. The Ward Leonard company has established a perpetual catalogue system, and will send a binder and leaflets to any one requesting them.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., is installing 4,000 automatic telephones and a complete switching equipment for the Home Telephone Company, of Los Angeles, Cal., and 1,200 for the Auburn Telephone Company, Auburn, N. Y. The company has received orders for the equipment of 12,000 automatic instruments for San Diego, Cal., and 1,500 for Lewiston, Me.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., is distributing section No. 12 of its catalogue of interlocking and signaling devices. This describes and illustrates the Union electric semaphore and the Union disc signal. Another recent publication of this company is an assemblage price list of the Westinghouse electropneumatic interlocking switch and signal system.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has issued the May number of "Graphite." This issue contains many interesting articles, among which are: "Cylinder Lubrication with Dry Graphite," by L. F. Lyne; "Mexican Graphite *versus* Flake Graphite as a Paint Pigment," and "Repairing and Adjusting Machinery," by W. H. Wakeman. Copy of this publication will be sent free on request.

THE HOLTZER-CABOT ELECTRICAL COMPANY, Boston, Mass., in bulletin No. 302 describes its line of dynamotors and motor-generators. In addition to a number of fine half-tone reproductions of various types of this machinery, there is an accurate description of the mechanism. The illustrations and descriptive matter pertaining to new types of telephone machinery are especially interesting.

THE GARVIN MACHINE COMPANY, Spring and Varick streets, New York city, will be pleased to send its complete illustrated catalogue descriptive of its metal-working machine tools. This catalogue describes in detail the mechanism of the various apparatus, and the text is supplemented by engravings showing the working parts. In addition to the catalogue matter there is some general information regarding calculations for the machine designer.

THE RECONSTRUCTED GRANITE COMPANY, 14 Dey street, New York city, publishes an attractive booklet describing reconstructed granite products for electrical insulation. Reconstructed granite consists of selected orthoclase granite, pulverized and moulded into any desired form under heavy pressure and then fused into a solid mass. The company manufactures the Courtenay type of insulator for third-rail systems, and also manufactures surface contact blocks locks.

THE LAIDLAW-DUNN-GORDON COMPANY, 114 Liberty street, New York city, describes compressors intended for pressure of thirty pounds and under in its new twelve-page pamphlet entitled "Low Service Compressors for Air and Carbonic Acid Gas." These compressors are built with open suction for supplying air at low pressure, or with closed suction for handling carbonic acid and other gases. The inlet valves are of the semi-rotary type, while the outlet valves are of the poppet type.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., manufacturer of the "P-K" specialties, has prepared a new series of blotters descriptive of its material. The company will be pleased to send sample and price of the plain fuseless rosette. In the cap of this rosette there are extra reenforcements along each side of the brasses, to keep them true and rigid under the pull line wires. There is also a recessed back that gives proper spacing of the wires to the ceiling, and protects the cap and contacts.

McKENNEY & WATERBURY, 181 Franklin street, Boston, Mass., as announced last week, will make every effort to render its showrooms attractive to attendants at the convention of the National Electric Light Association, which will be held in Boston, May 24 to 27. The company has on hand a complete line of fixtures for electrical work of every description. Special representatives will be in charge, and a cordial invitation is extended to all who may visit Boston, either during the convention or at any other time.

THE S. H. COUCH COMPANY, Boston, Mass., reports that it has recently closed several contracts for telephone equipment, among which are the following: the Lafayette Hotel, Portland, Me., which calls for 140 telephones and a 140-line common battery board of the company's new "Target" type. The Worcester City Hospital, Worcester, Mass., and the Hartford Carpet Corporation, Thompsonville, Ct., which calls for a common battery board and a magneto board for the Medfield Insane Hospital, Medfield, Mass.

THE MURRAY IRON WORKS COMPANY, Burlington, Iowa, has published its new catalogue No. 55. This company is the builder of Corliss engines, simple and compound, belted and direct-connected. The company also builds air compressors, boilers for all pressures, feed-water heaters and complete power plants. The catalogue is handsomely printed, and describes in detail the company's Corliss engines. There are a number of fine half-tone illustrations of the Murray standard Corliss engines of different sizes and for different requirements.

THE STANDARD VITRIFIED CONDUIT COMPANY, 39-41 Cortlandt street, New York city, is distributing a folder calling attention to its multiple-duct conduit. The front-page illustration shows this company's conduit in process of installation at the power-house of the Niagara Falls Power Company, Niagara Falls, N. Y. The company's conduit is used in the tunnel system of the Pennsylvania Railroad, between New Jersey and Long Island, the North river trolley tunnels, and the New York Central & Hudson River Railroad's tunnel work. The company is also the manufac-

turer of the Manhattan third-rail insulator, which has been installed on the Manhattan Elevated Railroad and the Interborough Rapid Transit Company's tunnel system in New York city; the Metropolitan Elevated, of Chicago; the Brooklyn Rapid Transit Company's system in Brooklyn, N. Y.; the Scioto Valley Traction Company, Columbus, Ohio, and the Mersey Railway system, London. The company will be pleased to send its new illustrated catalogue, which describes in detail the various products and gives a list of views of its process and factories.

THE COLUMBIA INCANDESCENT LAMP COMPANY, 2115-2119 Locust street, St. Louis, Mo., will be pleased to mail upon application a new booklet which it has prepared entitled "A Wallet Full of Wisdom." This booklet is attractively mounted within an imitation leather wallet and contains twenty-four pages of information of value to the consumer of incandescent electric lamps. The story takes up in detail the manufacture and quality of the Columbia lamp, and the literature is supplemented by half-tone reproductions of various views of the Columbia company's factory and various types of Columbia lamps.

THE GENERAL RAILWAY SIGNAL COMPANY, capitalized at about $5,000,000, is composed of the Taylor Signal Company, of Buffalo, N. Y., and the Pneumatic Signal Company, of Rochester, N. Y. On May 5 a party of capitalists from Rochester visited Buffalo and inspected the local plant. This party was met by a number of Buffalo people and a thorough inspection was made. Buffalo is to be made the headquarters of the merged signal companies, and it is expected that the organization will be perfected with the following officers: John J. Beckley, chairman of the board of directors; W. W. Salmon, of Buffalo, president; Frederick Cook, of Rochester, vice-president, and George D. Morgan, of Buffalo, secretary and treasurer.

THE AUTOMATIC SWITCH COMPANY announces that it now has headquarters at 106 and 108 Liberty street, New York city. The company has twice is former floor space with first-class facilities and is prepared to fill orders without delay. The company will be pleased to have enquiries concerning Whittingham controller switchboards and panels with solenoid starters, for pressure or pump work. The company is preparing a new catalogue which it expects to have completed within the next few weeks, and it will be pleased to forward a copy of this when desired. This catalogue will cover a line of controllers and switches for use in connection with electric elevators and the like, and will be in substantial form for carrying in the pocket for easy reference.

THE STUART-HOWLAND COMPANY, 4 and 5 Winthrop square, Boston, Mass., reports a decided improvement in business with the opening of spring. The company has recently secured several large orders, three of which are for shipment abroad. These, in addition to ordinary business, will keep a force busy for some time to come. The company is located in the heart of Boston, within one hundred feet of Summer street, and within four minutes' walk of the new terminal station. The offices and warerooms are large, light and airy, and especially convenient for handling goods at a minimum cost. It carries one of the largest and most complete line of electrical goods in the country, and the energy and enterprise of the company are well known throughout the trade.

THE WIRT ELECTRIC COMPANY, Philadelphia, Pa., announces the removal of its quarters to its new factory, corner Germantown and Sedgley avenues, North Philadelphia. The new factory is a three-story building, floor space on each floor being 60x80 feet, which doubles its facilities for manufacturing. The building is brick, of modern construction, and receives light from its four sides. The company has materially increased its equipment and the motive power is supplied by the Philadelphia Electric Company, separate motors being used for each department. The testing department is equipped for testing with 1,000, 400, 220 and 110, alternating current, and with 500 and 110, direct current. The office building is separate from the factory and gives them more commodious quarters than heretofore. One room in the office building will be fitted as a showroom for the display of rheostats, dimmers and dimmer boards, and battery charging rheostats.

THE ADAMS-BAGNALL ELECTRIC COMPANY, Cleveland, Ohio, in bulletin No. 18 presents a most interesting treatise on alternating-current series arc lighting. The literature is supplemented by engravings showing the type of lamp and regulator used with the Adams-Bagnall installation. Bulletin No. 35 discusses lightning arrester boards for alternating-current series arc lighting. These boards are manufactured by the Garton-Daniels Company, of Keokuk, Iowa. Interesting diagrams are given in this bulletin, showing the proper connections for the lightning arresters and kicking coils. Bulletin No. 25 gives directions for operating Adams-Bagnall constant-current alternating enclosed arc lamps with differential control. Bulletin No. 26 gives directions for installing Adams-Bagnall alternating constant-current regulators. There are a number of other bulletins, which call attention to the various engineering apparatus which the Adams-Bagnall company manufactures.

THE ELECTRIC EQUIPMENT AND SUPPLY COMPANY, 215½ Fourth avenue, Pittsburg, Pa., was incorporated, under the laws of the state of Pennsylvania, February 9, 1904. The business has been steadily increasing, each month doubling that of the previous period. The company at the present time is representing the Shelby Electric Company, of Shelby, Ohio, incandescent lamps; the Yost Electric Manufacturing Company, Toledo, Ohio, sockets, receptacles, etc.; the Pennsylvania Electric Manufacturing Company, Marietta, Pa., direct-current desk and ceiling fans, and also handles Westinghouse alternating-current desk and bracket fans. The company is placing on the market a line of specialties under the name "Esco," the idea being to secure only the very best material; and there will be a constant effort made to acquire a reputation for handling the best quality and giving customers entire satisfaction, both for service and prices. At the present time the specialties are confined to "Esco" tape and "Esco" incandescent lamps. These lamps have to pass a rigid specification and inspection, and are guaranteed. The company also handles the General Electric arc lamp, Westinghouse details and supplies, Marshall-Sanders sockets, switches and receptacles, "Diamond H" switches and receptacles, and, in fact, a full line of electrical supplies.

THE KEYSTONE ELECTRIC COMPANY, Erie, Pa., has recently published a series of bulletins and catalogues which contain material of considerable interest to the user of electrical machinery. One of these booklets is of neat size for carrying in the pocket, and gives a partial list of installations of power and lighting machinery manufactured by the Keystone company. In addition to this list there are illustrations of the Keystone apparatus and a brief description of the mechanism. Bulletin No. 4001 describes the switchboard apparatus built by the company. The frontispiece is a reproduction of the switchboard built by the Keystone company for the Whitehall Portland Cement Company, of Cementon, Pa. This consists of twenty-one panels, and presents a very handsome and workmanlike appearance. A large new catalogue which has been issued recently gives a number of illustrations, with brief description, of the products of the Keystone company. There are illustrated here engine-type generators, connected to both horizontal and vertical machines; motors of various descriptions, both open, semi-enclosed and enclosed. There are also shown a number of views of the front and back of switchboards which the company has built, as well as numerous applications of motors to machine tool work. In addition to the descriptive matter, there are a number of pages giving general dimensions of the machinery.

NEW INCORPORATIONS.

BLAND, VA.—Bland Telephone Company. $5,000.

AUGUSTA, ME.—Monarch Traction Company. $1,000,000.

ST. JOSEPH, MO.—De Kalb Telephone Company. $10,000.

PORTLAND, ME.—Fort Halifax Power Company. $250,000.

LANSING, MICH.—North Clayton Telephone Company. $5,000.

ALBANY, N. Y.—Whitney's Point & Glen Aubrey Telephone Company. $1,000.

COLUMBUS, OHIO—Chillicothe, Bainbridge & Aberdeen Electric Railway. $50,000.

CLINTON, IOWA—Tri-City Telephone Company. Increased from $135,000 to $600,000.

RICHMOND, VA.—Rural Retreat Mutual Telephone Company; $5,000. Patrick County Stuart Telephone Company; $5,000.

SPRINGFIELD, ILL.—New Holland Telephone Company. $2,500. Incorporators: J. Q. Collins, P. Kuhl, L. C. Schwerdtfeger.